# ABSTRACT BOOK


## 13TH INTERNATIONAL

# Coral Reef Symposium

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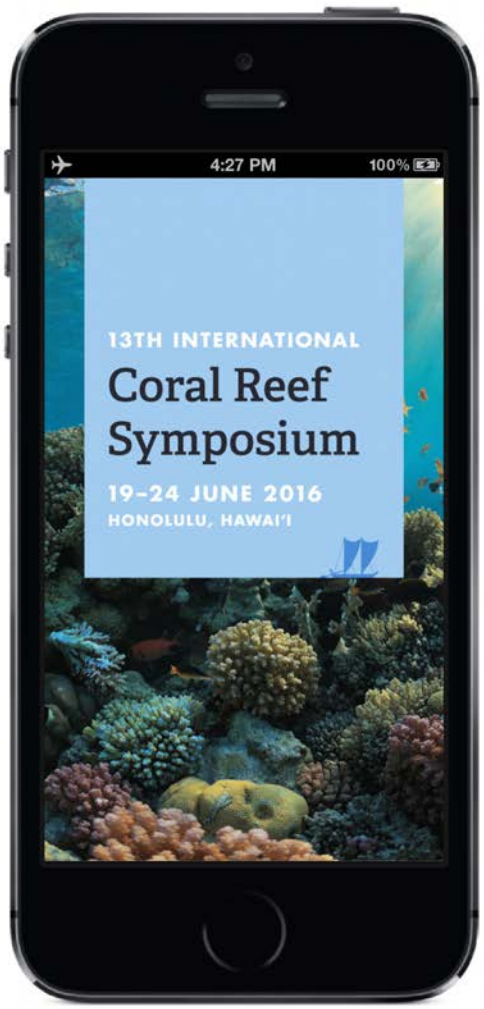


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TOWARDS DEVELOPING A FRAMEWORK FOR REEF RESILIENCE: A GREAT BARRIER REEF CASE STUDY (Abstract ID: 29211)

The resilience of the Great Barrier Reef to a changing climate is predicted to vary greatly across the 344,400 km2 and 2,900 individual reefs that make up the world heritage site. Resilience-based management allows responsive adaptation to this challenge. Understanding the capacity of the reef to resist and recover from a broad range of threats and disturbances it faces is crucial for long-term protection. The science of resilience has increasingly become the focus for measuring and managing reef health, however there are still significant gaps when it comes to how to operationalise resilience-based management. The Great Barrier Reef Foundation is convening experts in reef science, conservation and management to develop a globally applicable Reef Resilience Framework. The approach in developing the framework is integrative, collaborative and practical – it recognises the complexity of the ecosystem, is underpinned by the adaptive management principle and is cognisant of the need for communities as well as the ecosystems to adapt to climate change. The framework is intended to provide a mechanism to drive action towards building reef resilience and support resilience planning. It will aid in the assessment and prioritisation of key threats and support decision-making, particularly in relation to the implementation of effective management solutions designed to enhance ecosystem resilience.

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DIFFERENT GROWTH STRATEGIES FOR THE CORAL SPECIES SETTLED ON NEW MODEL MANUFACTURED OF SEMI-ARTIFICIAL SUBSTRATES, RED SEA, EGYPT (Abstract ID: 28593 | Poster ID: 179)

Growth and development of recognized coral recruits settled on the artificial model surface was recorded over two years at Hurghada, Red Sea. One soft and several hard recruits were recorded on the models surface. Different strategies of recruit development were performed. Accordingly, month of first species observed, number of polyps, species development with seasonal monitoring of the dimensional changes, seasonal variation in percentage of area development and increase in circumference of each species over the two years was carried out. This indicated a species specific pattern of development that differs significantly among coral families. These differences in the growth pattern of coral species are most probably related to the strategy used by each of the species to achieve its maximum growth and establishment of the colony to the substrate at the same time. Most common development pattern recorded follows the polynomial type, which indicated that the growth in the colonies dose not depend on the arrival of new recruits to the site but on the availability of certain parameters which may include food, illumination and temperature. So in most cases the asexual reproduction is the common type of reproduction until colonies reach certain size (or age) or develop mature enough individuals that are able to produce gametes.
http://reefdomeegypt.page.tl/

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HEAT SHOCK PROTEIN GENE HSP70 AS AN INDICATOR FOR DETERMINING THERMAL STRESS RESPONSE IN STYLOPHORA PISTILLATA FROM GULF OF SUEZ, RED SEA (Abstract ID: 28371)

The branching coral Stylophora pistillata is one of the most abundant hermatypic corals along the coasts of the Red Sea. It has been used for many years as a model species for coral biological studies. To examine thermal stress and any mutation would occur in Stylophora pistillata, we identified full-length sequence of Hsp 70 in samples of control and other samples after exposure to 26°C for 24h and 31°C for 72h. Relative quantification of gene expression level was measured for Hsp 70 in all thermal stressed colonies. Molecular modeling of Hsp 70 protein was made based on the ATP bound open conformation. After submission the sequence of Hsp 70 gene from Stylophora pistillata, GenBank assigned accession KP330265 for this sequence. Gene expression increased at 26°C for 48h than of 24h. It decreased at 72h in contrast expression of gene at 29°C. Gene expression decreased in 48h but increased in72h at high thermal stress of 31°C. Molecular modeling demonstrates that even though many amino acid residues of Hsp 70 protein were mutated after exposure to heat stress, the resultant mutants did not lose molecular interactions that might be necessary for protein stabilization and function.

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RESILIENCE-BASED MANAGEMENT IN REMOTE ATOLLS OF THE INDIAN OCEAN: AN OPERATIONAL CASE STUDY FROM THE MALDIVES (Abstract ID: 29591)

The Maldives is an archipelago containing approximately 1200 coral reef islands with more than 305 that harbor communities and permanent settlements that are heavily dependent on reef resources. Due to its vulnerability to climate change and its high resource-dependence, an urgent need to incorporate resilience science into conservation planning and local management was identified. Detailed ecological and socio-economic data for coral reefs and local communities were collected and mapped at a national scale. We developed a management framework that explicitly incorporates both ecological and social resilience, variations in human impact, uncertainty, and identifies the necessary interventions required to address multiple objectives in different atolls. The analysis identified atoll areas regularly used by local communities and private sector resorts, areas that present potential conflict between users, and finally ecologically significant areas. Specific locations were designated conservation priorities as they contain both ecological and social values that are not currently addressed by any existing management scheme. Systematic conservation and spatial planning processes were useful in identifying priority areas but are only effective if accompanied with innovative decentralized governance. Specific management actions are planned for each atoll and will be integrated into national policy.

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LONG TERM REEF HEALTH MONITORING (2004-2013) AT ABANG WATERS, BATAM CITY, RIAU ISLANDS PROVINCE (Abstract ID: 27786)

Long term reef health that was expressed as coral live cover and others reef benthics cover monitoring at Abang Waters, Batam City, Riau Islands Province. The aims of monitoring observed, whether the reef benthic covers were changed on a temporal and spatial scale. Reef Monitoring in 2013 is a nine (9) years period, since baseline on 2004 at 12 different sites. Reef health monitoring have used Line Intercept Transect (LIT) method, with ten meter transect long and three (3) transects for representated , and they were lied on 5-7 meter depth. Change of coral cover and others benthic on a temporal and spatial scale was analyzed by one-way ANOVA with further tested by Tukey with p=0.05. Result of monitoring shown that average of coral live cover was 50.71%, however live coral cover have been decrease compared in 2010 which their cover 68,62%. On a temporal scale, the result of monitoring have been shown that significant changed to several benthic cover included coral live cover Acoropora (p=0.04), Sponge (p=0.05) and Coral Ruble (p=0.003), whereas on a spatial scale, the all monitoring sites were experienced decrease in coral live cover. The environment factors were predicted by sedimentation loading and sea temperature stress was indicated by coral bleaching event in 2007 and 2010. The nine (9) years monitoring have been done which shown that decreased live coral cover, however not changed reef health condition Key Words: reef health, reef monitoring, coral cover, benthic cover, Abang Islands

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DISTINCT BACTERIAL COMMUNITIES OCCUR ON CORALLINE ALGAE THAT INDUCE HIGH CORAL SETTLEMENT. (Abstract ID: 30101)

Coral larvae must undergo a metamorphosis and settlement process in order to succeed in colony formation and contribute to reef growth. Crustose coralline algae (CCA) are known for their capacity to induce a metamorphic/settlement response in corals. CCAs vary in their capacity to induce these responses but the identity and role of their respective bacterial biofilms is not well understood. We set out to characterize the bacterial community of CCA species with different inductive capacities. Acropora millepora coral larvae were exposed to four different CCAs in multiple-choice assays. The bacterial communities of each CCA species were characterized by pyrosequencing of variable regions V1-V3 of the 16S rRNA gene. Two of the CCAs accounted for three quarters of all settlement. Despite all four CCA species sharing some bacterial groups, we found unique bacterial groups associated with the two species with the highest inductive

capacity . This study is the first to implicate roles for these novel bacterial groups in coral settlement. We will discuss our results in terms of the identity of these groups and their possible role in the inductive capacity of the CCA-bacterial community consortia.

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THE IMPACT OF PHILIPPINE MPA MANAGEMENT EFFORT ON HUMAN AND SOCIAL CAPITAL AND VICE VERSA: ASSIGNING NON-USE VALUES TO REEFS BEYOND ECONOMIC BENEFITS (Abstract ID: 29294)

Evidence strongly suggests that marine protected areas (MPAs) have the potential to provide ecological and economic benefits while balancing the trade-offs that come with stricter fisheries management measures. However, the effect of MPAs on social and human capital and MPAs' other non-use values in the Philippines has only been minimally explored. This study aims to determine and measure the impact of MPA management efforts on these benefits at the Philippine municipal level. Relying on contingent valuation techniques in the absence of complete data on the impact of MPA management on natural capital, this research aims to show the value that Philippine coastal society has affixed unto reefs beyond their monetary and economic benefits. Using the Management Effectiveness Assessment Tool (MEAT) and the newly developed Socio-Economic Assessment Tool (SEAT), the researchers compiled data on MPA management effort (using the MEAT) and socio-economic benefits derived from the MPA (using the SEAT) from focused group discussions with MPA managers. Taking data from 17 MPAs, it is evident that social and human capital is high and well-distributed among stakeholder communities along the coast; however, based on this study, this impact cannot be directly attributed to management effort as of yet. Our research suggests some revisions to the SEAT (e.g. on its leadership, social cohesion, education and health metrics) and some parameters to consider when assigning value to Philippine coral reefs to improve the social acceptability of protected areas.

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PUTTING THE SUCCESS OF BIOERODING SPONGES ON FUTURE REEFS INTO PERSPECTIVE: ENHANCED BIOEROSION VERSUS PHYSIOLOGICAL CONSTRAINTS OF *CLIONA ORIENTALIS* (Abstract ID: 27934)

Excavating sponges –which are one of the major groups of bioeroders on the reef– belong to the perceived winners under future climate scenarios. Ocean warming and acidification have been shown to boost their bioerosion capacity, but it remains unclear whether there are adverse physiological effects of these stressors that may counteract the enhanced bioerosion on the long run. We exposed the aggressive photosymbiotic bioeroder *Cliona orientalis* from the Great Barrier Reef to a prolonged temperature and acidity rise (according to the IPCC predictions for end of the century summer conditions under "business-as-usual" $CO_2$ emissions). Subsequently we monitored the physiological response of the sponge, focusing on changes to its carbon budget and bioerosion efficiency. Temperature stress resulted in extensive bleaching and occasional mortality, suggesting a strong dependence of the sponge on its zooxanthellate symbiont. Increased acidity alone did not have a profound effect on the sponge bioerosion or survival rates. When combined, these stressors led to a significant reduction in the energetic budget of the sponge, synergistically reducing rather than enhancing bioerosion rates. Overall this study points towards an impaired physiology of the sponge under the changed conditions, leading to the hypothesis that although *Cliona orientalis* may be able to survive future summers, its growth and bioerosion capacity will be substantially diminished.

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EXAMINING EDGE EFFECTS ALONG THE KUROSHIO CURRENT IN A SCHOOLING REEF PLANKTIVORE (Abstract ID: 29549)

Informed management in the face of rising anthropogenic pressure has become a priority for the sustainability of coastal fisheries in the Coral Triangle. Depauperate information on pelagic larval duration and behavior presents a particular challenge to understanding the scale of movement in many target reef species, particularly at the boundaries of species' ranges. In such cases, genetic analyses can illuminate dispersal patterns. Schooling, reef-associated caesionids are heavily impacted in regions with high artisanal fishing pressure. We collected tissue samples of *Caesio cuning* from five localities in the apex of the species' distribution to examine genetic connectivity along ~2000km of the Kuroshio Current from the Philippines to the northern extent of the species range in the Ryukyu Islands. Individual samples were barcoded and genotyped via RAD tags and the subsampled genomes were mined for a panel of SNPs to examine (1) levels and direction of gene flow between and among sites in the Philippines and Japan and (2) whether significant decreases in effective population size ($N_e$) at the limits of the species range can be detected. Characterizing genetic signatures from sites proximal to strong ocean currents and from the core to the periphery of the species range provides us with a clearer understanding of connectivity in *C. cuning* populations, helping to inform optimal management strategy for this species.

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COMPARATIVE ANALYSIS OF FORAGING BEHAVIOR REVEALS HIGH FUNCTIONAL DIVERSITY AMONG CARIBBEAN PARROTFISHES (Abstract ID: 30085)

Herbivorous fish and sea urchins play a critical role in the resilience of coral reefs by limiting harmful algae. The principal herbivores on many reefs are a diverse group of fishes, which are responsible for different ecological processes (e.g., provisioning of space for coral recruitment, bioerosion, the removal of macroalgae, etc.), and which have complementary impacts on benthic communities. Classifying herbivorous fishes into distinct functional groups based on their predicted impacts on reef ecosystems can inform resilience-based management strategies. We analyzed the behavior, diets, and bite mechanics of parrotfishes in the Florida Keys to document ecological diversity among the dominant herbivores on many Caribbean reefs, and to classify these species into functional groups. We found that in contrast to Pacific reefs, where most parrotfishes are categorized as scrapers and excavators, parrotfishes on Caribbean reefs include representatives of four major herbivore functional groups: scrapers, excavators, macroalgae browsers, and grazers. While fishes in different functional groups clearly have different impacts on benthic communities, we also found that species in the same functional group tended to select different habitats, feed from different substrates, and forage over different spatial scales, suggesting high levels of complementarity within functional groups, and implying that most species play a unique role in the ecosystem. By identifying key functional differences among parrotfishes, our results can inform management of Caribbean reef ecosystems.

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CAN CLIMATE ADAPTATION PORTFOLIOS MITIGATE RISK IN THE FACE OF UNCERTAIN IMPACTS OF GLOBAL CHANGE? (Abstract ID: 28746)

Marine conservation and management often focus on the preservation of 'pristine' areas in hopes that these areas will be robust to disturbance and repopulate degraded sites. However, as climate change occurs, the utility of any given site may shift tremendously such that now 'pristine' sites morph into ecological or evolutionary sinks. Given our poor capacity to anticipate the future, what is the best strategy for enabling successful coral reef adaptation to global change? One possible solution is constructing reserve portfolios that protect a diversity of coral species and provide raw evolutionary material across space. Such a portfolio of reserves may have the highest likelihood of capturing key sites and promoting geographic range shifts, physiological acclimatization, and adaptation via natural selection. We report a synthesis of coral traits a graphically outline a meta-community model that will quantify the costs and benefits of building reef adaptation portfolios relative to other conservation approaches, including the preservation of pristine locations. We suggest that diverse conservation portfolios are the key to promoting adaptation in the face of the irreducible uncertainties of global change. By designing management actions to enable billions of match-mismatch tests, nature can draw from these diverse portfolios to pick the winners of ecological reorganization and evolutionary adaptation.

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ECOSYSTEM APPROACH TO FISHERIES ASSESSMENT FOR A CORAL REEFS BASED MARINE CONSERVATION AREA IN TROPICAL SPHERE (Abstract ID:

29756)

Ecosystem approach to fisheries management (EAFM) has been suggested as the better option for managing the fisheries in Indonesia since the deliberation of Coral Triangle Initiative in which Indonesia is considered as the member of the initiative. Since that, EAFM in Indonesia has been improving from developing EAFM indicators for ecosystem approach to fisheries assessment (EAFA) methodology to the implementation of EAFM in a number of fisheries units, including in the MPA-based fisheries unit i.e. Gili Matra Marine Conservation Area of West Nusa Tenggara, Indonesia. This paper contributes to the experience of assessing EAFM Indicators using flag model based methodology. Results of the assessment show that relatively good condition has been achieved for the EAFM domain of fisheries resources, habitat, and economics, while for the fishing technology, social and institutional domain, the results are moderately good. A tactical decision approach suggested by Gavaris (2009) is used for taking some management actions to improve the fisheries performance at the Gili Matra MCA.

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ECOLOGY OF A TISSUE LOSS DISEASE OUTBREAK IN ACROPORIDS ON THE REEFS OF PALMYRA ATOLL, LINE ISLANDS (Abstract ID: 28935)

Disease outbreaks are a global problem on coral reefs including reefs in remote regions. Before we can predict and respond to disease events we must first understand the ecology and pathogenesis of these diseases. In 2011, we documented an outbreak of an acute tissue loss disease on acroporids in the remote region of Palmyra Atoll, Line Islands. Disease prevalence averaged 1.5% on the reef with surveys in prior years finding no signs of disease. Disease prevalence was similar the following year (2012) but disease progression had changed from predominantly acute tissue loss lesions (>5cm bare skeleton) to chronic tissue loss lesions (<5cm bare skeleton). The disease was still present in 2014 (10.4% prevalence) with both chronic and acute tissue loss lesions on corals. Aquaria studies showed the disease was transmissible through direct and indirect contact. Thirty-four tagged infected colonies followed for one year all had progressive tissue loss (avg. 42% loss) with a case fatality rate of 55.9%. Four of the remaining live colonies had signs of chronic tissue loss and the other 11 colonies showed no signs of disease. Treatment of lesions with a double band of marine epoxy, mixed with chlorine powder, was found to delay but not stop the disease. Histology revealed necrosis with a minority of colonies showing wound repair suggesting an ongoing active process. The bacterium *Vibrio coralliilyticus* strain OCN014 was isolated from diseased coral and was identified as a potential etiological agent based on laboratory infection trials.

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MARINE HABITAT CONSERVATION THROUGH SOCIAL MARKETING CAMPAIGN IN PAPUA, INDONESIA (Abstract ID: 30158 | Poster ID: 658)

Community support in the management of Marine Protected Area (MPA) management is a key for success. Social marketing through Pride campaign program has been implemented in 21 MPAs in Indonesia, Malaysia, and Timor Leste with the total area 171,112 ha. . The campaigns were to support behavior change of fishers to comply with the implementation of No Take Zone (NTZ) of the MPA to prevent the degradation of marine resources and promote sustainable fisheries, food security and biodiversity conservation. After two years of the program, social marketing campaigns succeeded in increasing the average levels of Knowledge, Attitude, Interpersonal Communication and Behavior Change across the campaign sites. The campaigns developed an overarching hypothesis of impact that captured the knowledge, attitude and behavior changes needed to reduce threats and achieve conservation results. These included increasing knowledge and conversations about the location and benefits of the protected area, reducing violations of the NTZ and stabilizing fish biomass and hard coral cover. The existence of NTZ could ensure food security for the people in the greater area. This paper will show the process and success story of the social marketing campaign to conserve marine habitat.

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INCORPORATING ECOSYSTEM SERVICES VALUES IN RESILIENCE-BASED MANAGEMENT: THE CASE STUDY OF A REMOTE INDIAN OCEAN ATOLL (Abstract ID: 29349)

Understanding the values of ecosystem services and integrating them into spatial conservation plans can allow policy-makers and managers to make decisions about use of resources. Ecosystem services provide a key link between ecological resilience, which supports ecosystem services, and social resilience, which is supported by ecosystem services. Managing marine areas for ecosystem services can thus promote socio-ecological resilience. However, measuring the values of ecosystem services and integrating this information into spatial plans remains challenging due to the complex nature of ecosystems and the services that they provide to people, as well as the paucity of data sets. In this study of the remote North Ari atoll in the Maldives, we collected ecological and social data and analyzed them to determine the total economic value of ecosystem services such as tourism and reef fisheries. A net present value analysis was undertaken in order to make the economic case for coral reef management. It was found that depending on the scenario, investments in developing and running managed areas yielded benefits of 15.8 – 75.7 million US$ annually for the atoll economy, depending on the discount rate used and the level of investment made in coral reef management. Ecosystem services were also mapped, and areas of high intensity of ecosystem services were identified. Recommendations were made for coral reef management in order to gain maximum benefits from ecosystem services and to promote socio-ecological resilience in North Ari Atoll.

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USING CORAL REEF SCIENCE IN MSP TO ACHIEVE PERFORMANCE-BASED ZONING (Abstract ID: 29434)

Marine spatial planning is being undertaken in many coral reef areas of the world, usually with the intent to maximize blue growth and promote integrated marine management. One way to ensure conservation of coral reefs are front and center in marine spatial plans and management is to use coral reef ecology and resilience science to design zoning plans that protect what is ecologically most important, while allowing sustainable use. Performance-based zoning allows the setting of very specific conservation and management objectives, and the implementation of management regimes within each zone to move toward achieving those objectives. Management must be designed so that scientific monitoring allows the assessment of performance, considering both ecological/environmental outcomes and social outcomes. Performance based zoning is not cast in stone but can be dynamic and should be regularly amended and updated in true adaptive management fashion. Geographically large scale MSP and zoning, especially that which integrates planning across the watershed and coastal landscape, can help to achieve true ecosystem-based management and will ensure that conservation does not take a back seat to economic development.

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ECOLOGY AND PHYSIOLOGY OF HIGH LATITUDE CORAL COMMUNITIES IN JAPAN UNDER PRESENT AND FUTURE CONDITIONS (Abstract ID: 29344)

Tropical corals are so threatened by climate change that high latitude marginal coral communities may be their last refuge. However, the future of these communities is still uncertain. We are assessing the future of high latitude coral communities and their ecosystems through a program that integrates monitoring, field and laboratory experiments and the use of volcanic CO2 seeps as a natural analogue for ocean acidification. We have studied 20 coral species off Izu, Japan (35°N). The lowest annual temperature (~12°C) often causes bleaching and favors overgrowth by macroalgae. Field incubations of two dominant species, *Porites heronensis* and *Alveopora japonica*, have shown the adverse effects of low temperatures on their physiology. We have found that the two corals have different recovery strategies: high mitotic index of the zooxanthellae in *P. heronensis* during summer and a likely shift to heterotrophy during winter for *A. japonica*. In the laboratory, the thermal performance of *P. heronensis* suggests that up to a 3°C increase in temperature would favor its growth. We are now comparing the performance

of corals and macroalgae at Shimoda (35°N, 12-26°C, low CO2), Shikine (35°N, 14-28°C, low CO2) and a CO2 seep off Shikine (14-28°C, high CO2) to determine the combined effects of global warming and ocean acidification at the boundary between kelp forests and tropical coral communities.

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ELEVATED $pCO_2$ SUPPRESSES THE INNATE IMMUNE RESPONSE OF THE CORAL *ACROPORA MILLEPORA* TO LPS CHALLENGE (Abstract ID: 28103)

Continued decline of corals reefs globally have been associated with increased anthropogenic stress. However the effect of these direct environmental stressors on the coral immune response is poorly understood though may promote disease due to an already compromised system. Evidence from mammals and *Drosophila* show that environmental stressful conditions impairs the immune response of the animal and that subsequent pathogen challenge causes increased mortality through disease processes. For corals little is understood on the influence of elevated $pCO_2$ on the animal's immune system and how subsequent additional challenges may impact coral health. Here we investigate the transcriptomic response of the coral *Acropora millepora* to the defined immunogen LPS, and the effects that pre-exposing corals to high $pCO_2$ conditions had on this response. Results from this study revealed that the coral implements key components of the vertebrate innate immune system as a response to an immune challenge. Interestingly, the LPS-induced response was impaired in corals exposed to high $pCO_2$ conditions, with suppression of crucial elements of the innate immunity including Toll-like receptors (TLR), tumor necrosis factor receptor (TNFR) and associate members observed. These results support the hypothesis that the innate immune response in corals might be compromise under future ocean acidification conditions.

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CORAL REEFS OF THE WESTERN INDIAN OCEAN – STATUS AND BLEACHING IN 2016 (Abstract ID: 29179 | Poster ID: 607)

The Western Indian Ocean contains under 5% of the world's coral reefs, but is hypothesized to contain the second hotspot of coral reef biodiversity globally. These coral reef ecosystems underpin the economies of the countries in the region, particularly fisheries and tourism sectors, and provide livelihood opportunities and income for local communities. However local threats, e.g. from overfishing, and global threats, e.g. from coral bleaching, are all increasing exponentially with regional human population growth and development. Concurrent with the GCRMN reporting on reef status for the region being finalized in 2016, the region is going through what has been dubbed the "3rd global coral bleaching event". Having been the region that suffered the most from the 1st global event in 1997-98, where mortality of 30-50% of corals was widespread, there is grave concern that 2016 may be as severe or worse. The reporting of reef status will compile summary data from participating monitoring programmes across the 10 countries of the region, following the model of the Caribbean GCRMN report published in 2014, and implementing a DPSIR approach. In terms of monitoring effort, the report emphasizes decreasing resources dedicated to monitoring, with most countries of the region posting declining monitoring from 2009 to 2015. The results of improved regional coordination and commitment of national teams through a coral bleaching response plan will be highlighted in the presentation, along with the levels of bleaching and their impact on overall reef status in 2016.
http://commissionoceanindien.org/activites/biodiversite/

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SHORT-TERM ECOLOGICAL IMPACTS IN THE BIRD'S HEAD SEASCAPE MPA NETWORK (Abstract ID: 28462)

Marine conservation strategies often allocate considerable resources towards the establishment and management of Marine Protected Areas (MPAs) with the expectation they will provide fisheries as well as biodiversity benefits. The "reserve effect" has been demonstrated repeatedly, though this is not universal. Here, we move beyond performance indicators to focus on impact evaluation methods that allow us to document and explain variation in the ecological impacts of MPAs. The recent establishment of an MPA network in the highly bio-diverse Bird's Head Seascape (BHS) in West Papua, Indonesia, represents an opportunity to robustly document the ecological impacts of MPAs, using state-of-the-art impact evaluation techniques. Building on an existing monitoring program in the BHS, we adopt a quasi-experimental design that enables causal inference through the explicit consideration of the counterfactual outcome, thus controlling for observable bias. This approach is critical to help disentangle MPA impacts from broader changes affecting the condition of BHS coral reefs. Ecological baseline and repeat data (every 3-4 years) was collected at seven MPAs at over 200 sites within different management zones and in over 50 sites outside of MPAs. Results indicate MPA ecological impacts vary in both magnitude and direction across indicators and MPAs. Using this novel approach to isolate MPA impacts provides further insights into the characteristics of the MPAs that influence ecological outcomes and subsequently facilitates MPA design to optimize conservation targets.

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THE TEMPERATE CORAL OCULINA ARBUSCULA EXHIBITS A HETEROTROPHIC RESCUE EFFECT TO TEMPERATURE STRESS (Abstract ID: 28217)

Anthropogenic increases in atmospheric carbon dioxide concentration have caused global average sea surface temperature to increase by approximately 0.11°C per decade between 1971 and 2010—a trend projected to continue through the 21st century. Research has demonstrated that increased SSTs compromise the coral holobiont (cnidarian host and symbiotic algae) by reducing host calcification and symbiont density. However, we are only beginning to understand the role of heterotrophy in the response of the coral holobiont to elevated temperature, particularly for temperate corals. Here, we conducted two independent experiments to investigate the influence of heterotrophy on the response of the temperate scleractinian coral *Oculina arbuscula* to thermal stress. Colonies of *O. arbuscula* from Radio Island, North Carolina were exposed to four feeding treatments (zero, low, moderate, and high concentrations of *Artemia sp.* nauplii) at two temperatures (average annual SST (20°C) and average summer temperature (28°C) for the period 2005-2012) to quantify the effects of heterotrophy on skeletal growth and symbiont density. Results suggest that heterotrophy produced a rescue effect for colonies exposed to higher temperatures, mediating reduced skeletal growth and symbiont density observed for unfed corals reared at the same high temperatures. Our study highlights the importance of heterotrophy in maintaining coral holobiont fitness under thermal stress and has potential implications for the interpretation of coral thermal stress response to climate change.

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FROM THE MICROBIAL SOUP AND THE SLIPPERY SLOPE TO SLIME, TO A NEW NORMAL FOR REEF CORALS (Abstract ID: 28330)

Climate change has contributed to worldwide increases in the frequency and severity of mass coral bleaching events and coral disease outbreaks. In recent years research into the coral microbiome has been directed at understanding the microbial contribution to coral death, disease and reef-wide decline. However it is the corals on reefs of today, and those that survive bleaching events, that will be integral to reefs of the future, under altered environmental regimes. The capacity to sustain a normal or 'healthy' microbial state during bleaching is likely to be a vital factor in coral recovery, survival, disease prevention and adaptation. Here we show that near future climate conditions result in an altered microbial state for corals that survive the breakdown of their algal symbiosis. But where previous research has linked a pathogenic or diseased microbial state to coral mortality from bleaching, here we show that non-pathogenic alterations to micro biome occur in corals that survive bleaching events (synonymous to an altered or 'dysbiotic', rather than symbiotic, state). The microbial state of corals surviving near future climate stressors is likely to have long-term implications to coral reef ecosystems.
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THE GREAT BARRIER REEF IS AT RISK OF LOSING THERMAL TOLERANCE (Abstract ID: 29279)

Coral bleaching events threaten the sustainability of the Great Barrier Reef (GBR). Here we show that bleaching events of the past three decades have been mitigated by induced thermal tolerance of reef-building corals and this protective mechanism is likely to be lost under near-future climate change scenarios. We show that 75% of past thermal stress events have been characterized a temperature trajectory that subjects corals to a protective, sub-bleaching stress, prior to reaching temperatures that cause bleaching. Such conditions confer thermal tolerance, decreasing coral cell mortality and symbiont loss during bleaching by over 50%. Importantly, we find that near-future temperature increases of as little as 0.5 °C result in this protective mechanism being lost, which may increase the rate of degradation of the GBR.

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RAPID AND HIGH PRECISION MEASUREMENT OF UREA USING HIGH TEMPERATURE: SIGNIFICANCE IN COASTAL ECOSYSTEMS (Abstract ID: 29109)

Urea is an unstable organic nitrogenous compound present in coastal environment derived from the excretion of some aquatic organisms, including human being. Recently it was recognized the importance of urea in nitrogen cycle since the discovery of implication of diatoms in the urea cycling. Therefore, accurate measurement of dissolved urea is required in coastal ecosystems. Production, consumption and degradation of urea are not well understood because of a lack of the appropriate measurement techniques. Therefore, we modified the conventional method from a room temperature to a high temperature system for measuring dissolved urea. Conventional method is based on the formation of colored product when urea reacts with diacetylmonoxime in sulfuric acid solution. High temperature (69°C) with single mix color developing reagent (COLDER) is our main modification. This method can determine about 10-12% more dissolved urea in different coastal environments (0.65-0.72 μM urea-N in coral reef, 0.49-0.58 μM urea-N in seagrass and 1.09-2.28 μM urea-N in mangrove) with 70 times faster measurement speed compared to room temperature procedures. Our results suggest that, high temperature procedure is more suitable, rapid and time saving than room temperature procedure with high precision (SD=0.001,CV=1.2%), high recovery (94-99%) and low detection limit (0.03 μM urea-N). Our method may provide an appropriate indication of the status of urea in nitrogen cycle in coastal communities.

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DISAPPEARING CORAL CAYS IN SOLOMON ISLANDS (Abstract ID: 27884)

Coral reefs and the ecosystem services they provide are of vital importance to societies yet are one of the most vulnerable ecosystems to the novel pressures arising from the 'super wicked problem' of contemporary global change. Sea-level rise has been predicted to cause widespread erosion and inundation on some of the low-lying coral cays sitting on top of reefs. However, there is limited understanding on exactly what type of islands are the most vulnerable and the timing and rate of changes. Here, we present the first analysis of coral sand cay dynamics from a sea-level rise hotspot in Solomon Islands. Using time series aerial and satellite imagery from 1947 to 2014 of 33 islands, along with historical insight from local knowledge, we have identified five vegetated reef islands that have vanished over this time period and a further six islands experiencing severe shoreline recession. Shoreline recession at two sites has destroyed villages that have existed since at least 1935, leading to community relocations. The large range of erosion severity on the islands in this study highlights the critical need to understand the complex interplay between the projected accelerating sea-level rise, spatial and temporal changes in climate drivers such as wave-driven processes and local tectonics, to guide future adaptation planning and minimise social impacts.

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REVERSAL OF OCEAN ACIDIFICATION ENHANCES NET CORAL REEF CALCIFICATION (Abstract ID: 28392)

Ocean acidification (OA) is projected to shift reefs from a state of net accretion to one of net dissolution this century. While retrospective studies show large-scale declines in coral calcification over the last decades, determining the relative contribution of OA to these changes is difficult due to confounding factors (e.g. warming). Here, we quantified the calcification response of a coral reef flat to alkalinity addition to test whether net calcification increases when ocean chemistry is restored closer to pre-industrial conditions. We used sodium hydroxide to increase the total alkalinity of seawater flowing over a reef flat, with the aim of increasing carbonate ion concentrations and aragonite saturation to values expected under pre-industrial atmospheric $pCO_2$ levels. We developed a dual tracer regression method to estimate alkalinity uptake (calcification) in response to alkalinity enrichment. This approach uses the change in ratios between a non-conservative tracer (alkalinity) and a conservative tracer (a non-reactive dye) to quantify the fraction of added alkalinity taken up by the reef. We estimate that the reef community took up 17.3% ± 2.3% of the added alkalinity, inferring a 6.9 ± 0.9% increase in net calcification. In providing results from the first seawater chemistry manipulation experiment of a natural coral reef community, we provide evidence that net community calcification is depressed compared to values expected for pre-industrial conditions, indicating that OA may already be impairing coral reef growth.

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UNDERSTANDING TRAJECTORIES OF RECOVERY AND DECLINE OF LAKSHADWEEP REEFS IN THE WAKE OF REPEATED CLIMATE DISTURBANCES AND THE CONSEQUENCES FOR FISH COMMUNITIES (Abstract ID: 28686)

As climate disturbances increasingly come to define the ecology of tropical reefs, understanding the trajectories that systems take in the wake of these events becomes critical to managing and enhancing their buffer capacity. We tracked changes in benthic cover and fish composition on reefs across the Lakshadweep Archipelago, characterised by low fishing and oligotrophic waters. In the wake of the 1998 bleaching, these reefs showed qualitatively different responses, driven mostly by storm exposure and depth. Stable reefs (typically deeper, protected sites) were largely resistant to bleaching and did not show major changes in coral cover. In contrast, Dynamic reefs (typically shallow, storm exposed sites) had coral compositions dominated by bleaching susceptible species but with very rapid rates of recovery linked to high recruitment of fast-growing competitive coral. Finally Degrading reefs (typically shallow, storm-protected sites) were characterised by bleaching susceptible species but with low post-disturbance recruitment and survival of coral. These trajectories in benthic cover had major consequences for several functionally important species of benthic, long-lived fish including groupers and corallivore butterflyfish that could only survive in stable reefs. Our results highlight that even in locations with relatively low fishing pressure, the imprint of climate change is changing basic ecosystem dynamics in large and unexpected ways.

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CATALYSING MANAGEMENT OF MARINE RESOURCES THROUGH A FISHER'S ELECTRONIC REGISTRY AND LICENSING SYSTEM (Abstract ID: 28018 | Poster ID: 566)

Governance on artisanal fishing effort is often a challenging task partly due to the inherent sparsity of these small-scale fishers, which frequently poses significant logistical constrains for the authorities. The fisher's electronic registry and licensing system built for the Department of Fisheries in Honduras is a web-based, low cost data handling system that is easy to use with a portable laptop and printer, efficiently emitting physical licenses that deliver a sense of direct participation to fishers. Through the progressive development of this practical, affordable and intuitive tool the authorities of coastal-marine resources are now generating opportune and accurate information on the degree and the distribution of the once underestimated artisanal fishing effort. The central database is also providing the basis for complementary fisheries management tools such as a catch data monitoring system and a participatory environmental crime watch web service.

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LONG-TERM CORAL COMMUNITY STABILITY IN A DISTURBED MARGINAL REEF IN KUWAIT (Abstract ID: 27921)

Coral reefs in Kuwait occur at high latitude (29 N) and in extreme environmental condi-

tions (SST range: 13 to 32 C, annually), and have been subject to chronic anthropogenic pressure in recent decades (recurrent bleaching, oil spills, chronic recreational anchoring and diving impacts). We intensively surveyed coral communities at six sites around Kubbar Island in 2015 and compared these to quantitative survey results collected at the same sites 31 years earlier (1984) as well as results from several sites resurveyed a decade ago (2003) in order to characterize changes in coral community structure in this marginal reef environment. Mean coral cover was 25% in 2015 compared with 34% in 1984, but declines in coral cover were significant at only one site. The decline in coral cover at this single site was mainly due to a >80% loss of formerly dominant Acropora, and a concomitant shift towards a lower cover community dominated by massives. A total of 13 coral genera were observed across sites, comparable to the 12 observed in 1984 and the 13 observed in 2003. Urchins have historically been considered an important bioeroder on Kuwait reefs, reaching densities of up to 100 m-2. Echinometra mathaei density averaged 9.7 urchins m-2 in 2015, far lower than the 62 urchins m-2 observed in the 1980s, suggesting that earlier observations represented a bloom following bleaching that occurred in the early 1980s. Overall, the results of this study show a high degree of long term stability in coral community structure in the marginal and heavily disturbed environment of northern Kuwait.

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DO DISEASES THREATEN THE CORAL REEFS OF KISH ISLAND, PERSIAN GULF? (Abstract ID: 29300 | Poster ID: 162)

Corals in the Persian Gulf exist in a harsh environment with extreme temperature and salinity fluctuations. Understanding the health of these hardy Gulf corals may prove useful for predicting the survival of other corals facing the impacts of global climate change. In this study, the health state of corals were surveyed along belt transects at four sites on the east side of Kish Island, Iran. Kish Island is located in the northern part of the Persian Gulf and is a favorite tourist spot. Within the four sites surveyed, a total of 474 colonies were found belonging to 13 coral genera. The dominant corals were Acropora (38% of the coral colonies), Porites (24.1%), and Favia/Favites (23%). Signs of excessive sedimentation occurred on all corals except acroporids and physical damage was found on 17% of the corals. Three tissue loss diseases (avg. prevalence±SE) were found in Porites including Porites multifocal tissue loss (8±2.3%), Porites chronic tissue loss (1±1%) and a Porites tissue loss disease, which had distinct peeling tissue at the lesion edge with a green exposed coral skeleton (7.25±3.7%). Another tissue loss disease, Favia subacute tissue loss, was also recorded (1±1%) but no signs of disease were observed on any of the other coral. Other coral lesions included pink discoloration in Porites associated with algae invasion or boring organisms, sponge overgrowth on Porites and mucus sheathing on Favia/Favites. The Gulf region is understudied and this represents one of the first surveys of coral health and disease on these reefs.

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ACCELERATING SCALING UP INITIATIVES TOWARDS SUSTAINING CORAL REEFS IN THE PHILIPPINES (Abstract ID: 29939 | Poster ID: 570)

The movement towards more effective coral reef conservation in the Philippines has shown considerable progress. Albeit, concerns persist as to whether the progress so far are enough to be able to catch up with the prevailing threats to coral reefs. Accelerated efforts are needed to improve the effectiveness of Marine Protected Areas (MPA) and scaling up efforts such as through MPA networks and local government alliances. We show that scaling up efforts can help achieve its target within our lifetime through multilevel governance. Efforts like the Marine Protected Areas (MPA) Support Network and other coordinated partnerships in Marine Key Biodiversity Areas (MKBA) are crucial. Using ecological connectedness, critical habitats and trigger species, envelope the priority areas of local and subnational governance initiatives. Protecting 10% of coral reefs has been projected to take a while, despite the significant increase in the size and rate of effective management. Areas needing urgent gap filling to meet future challenges are in the West Philippine Sea and the North Philippine Sea. Initial decades of accelerated marine conservation suggest improved effectiveness with national programs linked to local efforts and also to broader geographic arenas. National government agencies in collaboration with non-government organizations have made headway in finding synergies in marine biodiversity conservation. An overarching archipelagic framework needs to be implemented to pave the way to a Sustainable Philippine Archipelagic Development Agenda.

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DIFFERENTIAL EFFECTS OF CO2 AND WARMING ON PREDATOR-PREY INTERACTIONS IN CORAL REEF FISH (Abstract ID: 27925)

Ocean acidification and warming, driven by anthropogenic CO2 emissions, are considered to be among the greatest threats facing marine organisms affecting physiology and behaviour in fishes. We tested the independent and interactive effects of short-term elevated CO2 and temperature exposure on the predator-prey interactions of common pairs of coral reef fishes (Pseudochromis and Pomacentridae) as well as the effect of elevated CO2 exposure on the escape responses of juvenile fish and whether such effects are altered by transgenerational acclimation. We found predator success increased following predator and prey exposure to elevated CO2 and temperature. Overall, high temperature had an overwhelming negative effect on the escape behaviour of the prey compared to the independent effect of CO2 or the combined exposure to elevated CO2 and temperature. We observed little influence of CO2 on the behaviour of the predator, suggesting that attack behaviour was robust to this environmental change. Finally we found that elevated CO2 negatively affected the reactivity and locomotor performance of juvenile fish, but transgenerational acclimation reduced these effects. These are the first studies to address how the kinematics at the basis of predator-prey interactions may change in response to independent and concurrent exposure to elevated CO2 and temperature, and whether there is any potential for acclimation to occur.

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FISHING DOWN NUTRIENTS: SELECTIVE HARVEST REDUCES NUTRIENT CAPACITY IN CORAL REEF ECOSYSTEMS (Abstract ID: 29597)

Overfishing is a major driver of global coral reef declines and is associated with reduce biodiversity within these ecosystems. Overwhelming evidence demonstrates that biological diversity is a primary driver of ecosystem function, providing important motivation for conservation efforts. Yet while it is clear that biodiversity loss can reduce ecosystem functioning, there are many other underlying drivers by which humans exact changes to ecological communities. Here we show that although species richness is a good predictor of ecosystem function in highly diverse coral reef ecosystems, it is not a primary driver of ecosystem function loss in the context of one of the greatest threats to marine biodiversity (over-fishing). We modeled five nutrient processes of storage and supply, herein "nutrient capacity", and multifunctionality onto 143 species of coral reef fishes across 110 coral reef fish communities, ranging from heavily fished to protected. We found that despite no substantial changes in the number of species within a community, fishing reduced ecosystem functioning by nearly half. Instead the primary driver of reduced ecosystem function was changes in trophic structure of the communities due to targeted fishing of select species. There is a clear need to protect against species loss, but if a primary goal is to maintain high levels of ecosystem function, focusing conservation efforts on maintaining trophic structure and community size structure is critical. http://faculty.washington.edu/jeallg/Home.html

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UP-REGULATION OF CALCIFICATION FLUID PH IN MASSIVE PORITES SPP. CORALS: A RESPONSE TO COMPENSATE FOR OCEAN ACIDIFICATION EFFECTS (Abstract ID: 29293)

We acclimated multiple sub-colonies of four genotypes of massive Porites spp. corals at 25°C and 2 seawater pCO2 concentrations representing the present day (400 ppm) and future atmospheric conditions (750 ppm) for > 5 months. At the end of the acclimation, calcification rates were significantly reduced (typically by 30-60%) in three of the genotypes in the high seawater pCO2 but were unaffected in one genotype. We analysed the boron isotopic composition of the skeleton deposited after the acclimation period to estimate the pH of the extracellular fluid used for calcification. Corals actively increase the pH of the calcification fluid above that of ambient seawater, increasing the proportion of dissolved inorganic carbon present as CO32- at the calcification site and yielding high aragonite saturation states, favourable for the precipitation of the skeleton. All corals at high seawater pCO2 upregulated calcification fluid pH more than their lower pCO2 counterparts thereby partially offsetting the reduction in seawater pH associated with high seawater pCO2. At 750 ppm CO2, two of the genotypes attained the same calcification fluid pH observed at 400 ppm. We observed a strong correlation between calcification fluid pH and coral calcification rate. Our data show that some massive

Porites corals are able to adapt to high seawater pCO2 by upregulating calcification fluid pH to maintain the high calcifying fluid pH required for rapid calcification. We do not know the energetic cost of this adaptation but it persists beyond several months.

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LARVAL FISH DISPERSAL IN A CORAL REEF SEASCAPE (Abstract ID: 28238)

Larval dispersal is a critical yet enigmatic process in the persistence and productivity of marine fish metapopulations. We quantified larval dispersal among 8 subpopulations of clownfish (Amphiprion percula) and butterflyfish (Chaetodon vagabundus) in a network of marine reserves spaced between 10 and 120km apart across a ~10,000km2 seascape in Papua New Guinea. Observed dispersal distances matched well with a modeled exponential declining function for A. percula, providing a mean dispersal of 15-20km and 95% of recruitment occurring within 30-45km of the source. The observed mean dispersal distance was longer (50-60km) for C. vagabundus with the modeled dispersal kernel declining only gradually from spawning locations. Our study showed that dispersal can be empirically measured on a spatial scale sufficient to parameterize spatially-explicit models and evaluate the design and performance of networks of marine reserves.

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FROM LEAF NETS TO ARBALETES - BLENDING TRADITIONAL AND MODERN METHODS TO COLLECT SAMPLES FOR LARVAL DISPERSAL RESEARCH AT KA'UPULEHU, HAWAI'I (Abstract ID: 30052)

Fishing community engagement in scientific research accomplishes multiple objectives including increased efficiency obtaining samples from target species, increased understanding of research results, and improved advocacy for management initiatives. We worked with Hawaiian elders and fishermen to use traditional methods of group fishing as well as innovative spearguns to collect samples for a genetic study of the resource fish species *Acanthurus triostegus*, or Manini. Utilizing both ancient and modern technology, we were able to collect sufficient samples of this important resource fish species to derive information on larval dispersal in west Hawai'i Island. In this presentation, we consider the efficacy of different methods used to obtain fish and propose that abandonment of traditional fishing methods may be a function of declines in fish abundance as much as other barriers to traditional practice and offer an example of political advocacy from an unlikely source following direct engagement in scientific data collection.

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MARINE PROTECTED AREAS BUFFER DIRECT AND INDIRECT EFFECTS OF MONSOON SEASONALITY ON TROPICAL SEAGRASS FISH COMMUNITIES (Abstract ID: 28162)

Climate change is expected alter not only the general climate patterns but also seasonal variability, with direct and indirect effects on species and ecosystems. Marine protected areas (MPAs) are known to rebuild fish stocks, increase local biodiversity and strengthen ecosystem functions. However, the extent to which they can sustain the full diversity of ecosystem services in a changing climate is still unclear. Here, we investigate the interactive effects of MPAs and monsoon seasonality on seagrass associated fish communities. We carried out a field survey in two marine protected areas (MPAs, no-take zones) and two non-protected (fished) sites around Zanzibar (Tanzania) during three monsoon seasons in 2014-2015. Fish and seagrass community surveys were conducted in replicated transects. Since seagrass cover may vary between seasons, which in turn could affect the associated fish community, we used path analysis to discern whether seasonality affects fish communities directly, or indirectly through effects on the seagrass beds. Within MPAs, we found no direct or indirect effects of seasonality on seagrass fish. In fished areas, there was both a direct effect on juvenile, sub-adult, and adult fish densities; and an indirect effect (mediated by seagrass cover) on total and sub-adult fish densities. Despite the low level of replication (two MPAs), our findings suggest that well enforced MPAs could play an important role in buffering some of the direct and indirect effects of future climate variations on fish communities, and thus in the maintenance of ecosystem services.

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HIGHER MORTALITY BUT INCREASED GROWTH RATES OF CORAL ON IMPACTED REEFS AT JEDDAH, SAUDI RED SEA (Abstract ID: 29082 | Poster ID: 103)

ABSTRACT The coast of Saudi Arabia contains many of the best developed fringing reefs in the Red Sea. However, coral communities on reefs closest to central Jeddah has been badly affected by a wide range of impacts including extensive coastal infilling, discharge of untreated as well as treated sewage, unregulated fishing, coral bleaching and disease, and outbreaks of Crown-of-thorns starfish. Coral growth has been widely used as a proxy for reef health and, to inform measures intended to improve environmental conditions, we used an experimental approach to assess which of these impacts had been most critical. Coral fragments of two species (Acropora hemprichi and Pocillopora verrucosa) were cultured in mid-water suspension (so as to minimise the impact of benthic predators and sediment deposition) at 6 different sites located north and south of Jeddah. Survivorship and growth rates were monitored as well as chemical and physical parameters and the associated bacterial biota. Results revealed that the mean rate of coral growth was actually higher at some of the impacted sites, especially those closest to sources of domestic and municipal sewage at which nutrient levels were found to be elevated. However, coral mortality was also higher at these same sites and coral cover on adjacent reefs lower. The differences in survivorship between sites may reflect reduced health of coral fragments, higher rates of growth of competitive turf algae, reduced rates of grazing by herbivorous fishes and changes in associated bacterial fauna at the sites most subject to impact.
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TROPICAL DEAD ZONES AND THE COLLAPSE OF CORAL REEFS (Abstract ID: 29618)

Hypoxic dead zones are an increasingly common form of coastal habitat degradation that can have catastrophic consequences for biodiversity, ecosystem function, and human wellbeing. Dead zones are known primarily from temperate regions, but little is know about the potential threat of hypoxia in the tropics, despite the fact that risk factors, including eutrophication and elevated temperatures, are commonplace. Here we document an unprecedented hypoxic event on the Caribbean coast of Panama and assess the global risk of dead zones to coral reefs worldwide. The event caused massive mortality to corals and other reef-associated organisms, but observed shifts in community structure combined with laboratory experiments revealed that not all coral species are equally sensitive to hypoxia. Analyses of global databases suggest that tropical dead zones have been severely under-reported, perhaps by an order of magnitude, due to lack of local scientific capacity for their detection. Our findings suggest that dead zones have already impacted the structure and function of coral reefs, and that a comprehensive understanding of dead zone dynamics requires consideration of tropical ecosystems. The growing threat of coastal hypoxia should be incorporated into monitoring and management plans for coral reef resilience.
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A CRITICAL EXAMINATION OF THE LINKAGES AND OUTCOMES OF BIODI-

VERSITY VS. FISHERIES CONSERVATION INTERVENTIONS FOR CORAL REEF SYSTEMS (Abstract ID: 29493)

Two of the premier goals of marine conservation are to achieve sustainable fisheries, and maintain biodiversity. It is often assumed that these goals are compatible because of strong and positive functional links between them. For example, in contrast to complete dependence upon a single prey taxon, a diverse assemblage of forage species can better support populations of commercially targeted fish predators. Also, sustainable fishing practices can enhance biodiversity by reducing bycatch of non-target species. However, there is also a great potential for negative tradeoffs from interventions that support immediate human needs (eg fishing) versus those that support long-term human wellbeing (eg resilience through biodiversity pathways). These are particularly severe in coral reef environments, a model for ecosystem service flows in hyperdiverse tropical systems. While many conservation strategies here take for granted the existence of a strong and positive link between sustainable fishing and biodiversity, the question has not been subject to critical evaluation To bridge this knowledge gap we have sought to: 1) identify interventions routinely deployed to achieve sustainable fisheries or biodiversity maintenance on coral reefs, 2) consider the set of theoretically possible and likely outcomes that result, and 3) illuminate these based upon a literature review and expert workshop, to understand the outcomes of these interventions in real world environments. We discuss our results in the context of operationalizing marine ecosystem-based management in coral reef environments.

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SHIFTS IN CORAL-ASSEMBLAGE COMPOSITION DO NOT SECURE REEF FUNCTIONING (Abstract ID: 29735)

Coral communities are changing rapidly worldwide through loss of coral cover and shifts in species composition. Although many reef-building corals are likely to decline, some weedy opportunistic species might increase in abundance. Here we explore whether the reshuffling of species can maintain ecosystem integrity and functioning. Using four common Caribbean reef-building coral genera we modeled rates of reef construction and complexity. We show that shifting coral assemblages result in rapid losses in coral-community calcification and reef rugosity that are independent of changes in the total abundance of reef corals. These losses are considerably higher than those recently attributed to climate change. Dominance patterns of coral assemblages seem to be the most important driver of the functioning of coral reefs and thus, the future of these ecosystems might depend not only on reductions of local and global stressors, but also on the maintenance of keystone coral species.
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THE MAINTENANCE OF CORAL BIODIVERSITY VIA RELATIVE NONLINEARITY OF COMPETITION (Abstract ID: 28929)

The high levels of biodiversity in reef coral assemblages have proven difficult to explain solely by niche partitioning. Other coexistence-promoting mechanisms, such as the storage effect, must therefore be operating. Relative nonlinearity of competition is a coexistence-promoting mechanism that allows each species to be favoured under different resource levels due to differences in the functional response of the per-capita population growth rate to resource availability. To date, it has only been shown in highly idealized model communities. In reef-coral assemblages, where space is a limiting resource, this mechanism could arise from differences in size-dependent susceptibility to mechanical disturbance between growth forms. We tested for relative nonlinearity of competition in reef-coral communities using competition models that we calibrated with empirical estimates of demographic rates for two different pairs of competitors (tabular vs. digitate corals and tabular vs. massive corals). Results revealed that the tabular species is favored under low resource availability (i.e. when coral cover is high), while digitate and massive corals are favored under high resource availability. This occurs because the tabular corals are superior competitors in calm conditions, where large and fecund colonies are present in the population. After a disturbance, the large tabular corals are dislodged, reducing the population fecundity of tables, relative to their competitors. Our results confirm the plausibility for coral reefs of this previously hypothetical mechanism of coexistence.

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SCIENCE-INFORMED CONSULTATION, PUBLIC INVOLVEMENT, AND MANAGEMENT DECISIONS:PLANNING A MARINE RESERVE IN BISCAYNE NATIONAL PARK, USA (Abstract ID: 28418 | Poster ID: 632)

The National Park Service (NPS) approved a 2015 management plan for Biscayne National Park that included a 10,512 acre marine reserve protecting a third of the park's reefs. The plan was a culmination of fifteen years of planning that included 22 public meetings with 1000 attendees, 43,000 public comments, and three plan versions. The marine reserve was controversial, with opposition to fishing restrictions and arguments for greater reef protection. Following a 2012 Congressional hearing on the draft plan, the NPS consulted with the State of Florida to offer two new restricted-fishing alternatives in lieu of a marine reserve: one alternative with a zone with required special fishing permits and another with a seasonal fishing zone. Following new information on the state of the park's reefs after the 2014 and 2015 coral bleaching events, new studies on marine reserves and impacts of seasonal closures and restricted fishing on targeted fish species and recreational fishers, and extensive public comments, the NPS chose a marine reserve. After a 2015 Congressional hearing on the final plan, the NPS made a commitment to monitoring and research, in consultation with appropriate federal and state agencies, for up to 20 years to determine the extent to which the reserve achieves its stated goals as compared to baseline conditions. Another key commitment is that the NPS will consider recommendations during this timeframe on monitoring protocols as well as whether to continue or modify the marine reserve, including its size, geographical extent, and specific rules and restrictions.

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SISTER SPECIES OF THE ORDER ZOANTHARIA (CNIDARIA: HEXACORALLIA) BETWEEN ATLANTIC AND PACIFIC/INDIAN OCEANS (Abstract ID: 28483)

Understanding speciation processes is one of the main questions in evolutionary biology. Among benthic taxa, zoantharians (Cnidaria: Hexacorallia) comprise an abundant group in shallow waters, and colonies are used as shelter or food source. Furthermore, they are an interesting model to investigate closely related species, as there are reports of sister species with highly similar molecular sequences from different ocean basins (Atlantic and Indian/Pacific). However, no study has analyzed such pattern in zoantharians and which are these pairs remains unknown. Herein we investigated closely related representatives of the order Zoantharia performing phylogenetic analyses of genera that have species in both oceans basins. In addition, we analyzed species morphological data. Our aim is clarify which are these pairs and discuss how this pattern was likely generated. There are nine zoantharians pairs where one species is reported from the Atlantic Ocean and another from the Pacific/Indian oceans in four out of ten genera analyzed. These sister species present identical mitochondrial and closely related nuclear sequences in addition to highly similar morphological characters. The frequency of sister zoantharians reveals an unusual pattern compared to what is known for shallow-water reef animals, like corals and most fishes, which have deep genetic distances between species from different ocean basins. Due to this high occurrence of pairs and to the species widely distribution within an ocean, it is likely that a vicariant event(s) has led to sister species in Zoantharia.

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ALGAL BIOASSAYS SHOW LAND-BASED, ANTHROPOGENIC NITROGEN IS DELIVERED TO REEF BIOTA BY GROUNDWATER IN HAWAII AND AMERICAN SAMOA (Abstract ID: 29691)

Submarine groundwater discharge (SGD) is a source of land-based contaminants to coastal ecosystems, yet the impact of this process on marine biota remains understudied. To determine if plants assimilated SGD-derived nitrogen (N) on otherwise oligotrophic reefs, we compared the N parameters ($\delta^{15}N$ values and N concentration) of naturally occurring macroalgae with those of surface water, coastal groundwater, and terrestrial groundwater in Hawaii and American Samoa. In addition, tissues of *Ulva*spp. were deployed for 5-6 days to determine the extent of nutrient pollution at 8 coastal sites in Hawaii. Reduced salinity, elevated $^{222}Rn$, and high nutrient levels in beach porewater and surface water relative to ambient marine water provided evidence that SGD was a sub-

stantial vector for nutrient delivery to all study sites. The highest $\delta^{15}N$ values in algal and water samples were found adjacent to wastewater treatment facilities that dispose treated effluent into groundwater via injection wells in Hawaii. The lowest $\delta^{15}N$ values and highest N concentrations in water and algal tissues were found at locations adjacent to sugarcane fields. On Tutuila, high $\delta^{15}N$ values in nearshore algal and water samples, relative to a control site, suggest that wastewater was a source of N to reefs adjacent to three villages. In general, regions with little human impact had relatively low N concentrations and $\delta^{15}N$ values. Within developed regions of Hawaii and American Samoa, SGD delivered N derived from wastewater and fertilizer to marine macroalgae across large spatial scales.

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THE PERFECT STORM: MATCH-MISMATCH OF BIOPHYSICAL EVENTS DRIVES LARVAL FISH CONNECTIVITY BETWEEN PULLEY RIDGE MESOPHOTIC REEFS AND THE FLORIDA KEYS (Abstract ID: 29346)

Mesophotic coral reef ecosystems are remote from coastal stressors and may be the key to resilience. While they remain for the most part exposed to fisheries overexploitation, nothing is known so far about larval fish connectivity between mesophotic and shallow ecosystems. We use a biophysical model to test the hypothesis that Pulley Ridge, a mesophotic reef in the Gulf of Mexico that hosts a variety of shallow-water tropical fishes, may replenish shallow fish populations in the Florida Keys. To identify spatio-temporal patterns of vertical connections we developed a 3-D coral reef habitat module for the open-source Connectivity Modeling System and simulated larval transport of a demersal spawner, the bicolor damselfish Stegastes partitus. Virtual larvae were released daily between 60-80m from Pulley Ridge over 60 lunar spawning cycles, and tracked until settlement within a high resolution (900 m) regional hydrodynamic model. These probabilistic simulations reveal mesophotic to shallow connections with large, yet sporadic pulses of larvae settling in the Florida Keys. Modal and spectral analyses on the spawning time of settled larvae, and on the position of the Florida Current front along Pulley Ridge, demonstrate that specific physical-biological interactions modulate these "perfect storm" events. This study demonstrates that mesophotic coral reef ecosystems can also serve as refugia for coral reef fish and suggests that they have a critical role in the resilience of shallow reef communities.

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A FIVE YEAR ASSESSMENT OF CORAL IN FAGA'ALU BAY, AMERICAN SAMOA - HAS FIVE YEARS OF MANAGEMENT MADE AN IMPACT? (Abstract ID: 27799)

Faga'alu Bay on Tutuila island in American Samoa is an US NOAA National Priority Watershed, and has shallow nearshore reefs along the bay edges. In 2012, four long-term transects were laid by installing six steel pins for each transect, with two transects on each bay side to allow for comparative monitoring. One side of the bay is heavily influenced by stream effluent, which carries high loads of sediment from a quarry, while the other side of the bay is rarely reached by the stream plume. Photoquads were taken along transects on a quarterly basis each year and will be analyzed for percent live at the functional level with the following categories: hard coral cover, rubble, crustose coralline algae, and macroalgae cover. Based on field observations, we expect data to show the bay side with minimal stream influence to be more resilient to current bleaching and Crown of Thorn Starfish impacts, leading to higher overall live coral cover. Conversely, we expect data to show the bay side influenced by sediment to have lower live coral cover, based on observations of a lack of new growth. The rock quarry implemented extensive new sediment management techniques in 2012-2014, thus we hope results of the analysis will show reduced macroalgae and new coral growth on the less impacted side of the bay.

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SYNERGISTIC EFFECTS OF OCEAN WARMING AND ACIDIFICATION ON GROWTH AND SURVIVORSHIP OF COMMON REEF-BUILDING CORALS (Abstract ID: 28537)

Ongoing climate change is considered to be one of the greatest threats to the persistence of reef building corals. More specifically, increasing temperatures are expected to be compounded by ocean acidification, leading to declines in abundance and survivorship of corals. To determine how corals will respond to the combined effects of warming and ocean acidification, two common and fast growing *Acropora* corals (*Acropra muricata* and *Acropora hyacinthus*) were used in a fully factorial experimental study using three temperature treatments (26 °C, 28.5 ° C and 31 ° C) crossed with three levels of $pCO_2$ (400 ppm, 675 ppm and 950 ppm). Future temperature stress caused a 10 % decline in survivorship, and 10-50 % decline in calcification across both coral species. End of century $pCO_2$ reduced survivorship and over long-term lead to 50 % reduction in calcification. Therefore, temperature had a bigger negative effect than $pCO_2$. Without adaptation or acclimation, branching corals species most sensitive to temperature stress and ocean acidification are likely to suffer from declines in health and survivorship that would drastically reduce reef complexity, and cause shifts in ecosystem function.

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A FUNDAMENTAL PARADIGM FOR CORAL REEF CARBONATE SEDIMENT DISSOLUTION (Abstract ID: 29975)

The success of coral reefs depends on a positive balance of calcium carbonate production exceeding dissolution, erosion, and material export. As a result of ocean acidification, coral reefs could transition from net accretion to net erosion owing to decreasing rates of calcification and increasing rates of CaCO3 dissolution and bioerosion. Here, we present a fundamental paradigm that aims to explain the main driver of carbonate sediment dissolution on coral reefs based on theory and empirical datasets of pore water carbonate chemistry from diverse reef locations in the Atlantic and Pacific. We suggest that carbonate sediment dissolution is most strongly controlled by the extent of organic matter decomposition in the sediments, but that the magnitude of dissolution is influenced by how much decomposition is required to reach pore water undersaturation with respect to the most soluble bulk carbonate mineral phase present in the sediments, a condition defined as the Carbonate Critical Threshold (CCT). Decomposition of organic matter beyond the CCT under aerobic conditions results in stoichiometric proportional dissolution of carbonate sediments. As ocean acidification proceeds over the next several decades, the extent of organic matter decomposition required to reach the CCT will decrease, carbonate dissolution will increase, and subsequently the accumulation of carbonate sediments will decrease.
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ANALYSIS OF THE COMPETITION BETWEEN LOBOPHYTUM PAUCIFLORUM WITH TWO HARD CORALS (Abstract ID: 29069)

Competition between colonies has shaped coral reef communities throughout their evolutionary history. The product of individual interactions is the overall health of a colony, and if the colony's immune system is compromised, it is less likely to win a competitive interaction. Observational studies imply that contact with, or proximity to competitors triggers immune responses and defense mechanisms on hard corals. The limited research that has been done on coral immunity has focused on hard corals, and little is known about the molecular responses of soft corals to immune challenge or contact with other corals. To understand the molecular responses of corals in non-contact competition we used an experimental approach. Fragments of the soft coral L. pauciflorum were placed in individual tanks together (not in contact) with nubbins of one of two hard coral species: A. millepora/P. cylindrica. The species, selected because of the extensive molecular datasets existent, will enable comprehensive gene expression analyses. The behavior of both hard and soft coral in these experiments was monitored over the following two months, and samples taken for gene expression analysis. Aggressive behavior was observed by the hard corals towards the soft coral, and preliminary results imply that the presence of the soft coral affected the polyp activity of the hard corals. These results suggest that hard corals were reacting in proximity to a potential competitor. Gene expression analyses are under way to enable a deeper understanding of the molecular bases of this competitive interaction.

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USE OF MESOPHOTIC CORAL ECOSYSTEMS BY INVASIVE WESTERN ATLANTIC LIONFISH (Abstract ID: 28308)

The severe negative effects of invasive lionfish (*Pterois volitans* and *Pterios miles*) on western Atlantic shallow reefs are well documented, yet despite lionfish recorded on deeper reefs, the use of mesophotic coral ecosystems (MCEs) in invasive lionfish ecology and life history remains a significant gap in our knowledge. We combine studies of lionfish abundance and body length on shallow (0-30m) and mesophotic (30-150m) reefs from 63 sites in seven western Atlantic countries. Lionfish were found at similar abundances on adjacent shallow and mesophotic invaded reefs and in some locations MCE lionfish were larger than shallow individuals. This suggests MCEs may form part of a natural ontogenetic migration, with older lionfish found at greater depths. To further understand these patterns we conducted detailed lionfish surveys around Utila, Hondruas from 5-85m depth during June-September 2015. Our results indicate a depth refuge around Utila, with greater densities of larger lionfish recorded on MCEs than shallow reefs. We took detailed measurements and dissection data of circa. 500 lionfish across this depth range. Male lionfish were found to be more reproductively mature on MCEs than shallow reefs, though interestingly reproductive maturity and mean gonad weight was not found to be different with depth for female lionfish. This study highlights the need for lionfish adaptive management to consider lionfish populations below the depth limit of recreational SCUBA diving, as the focus of most previous control (culling) measures has been shallow water.

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QUANTITY, NOT QUALITY – FIRST LARGE-SCALE CENSUS OF INDO-PACIFIC SCLERACTINIAN CORALS (Abstract ID: 30102 | Poster ID: 702)

Over the past centuries, the global abundances of humans and most wild species have followed markedly opposite trajectories. While the human population has grown exponentially, an increasing number of species is considered threatened by extinction, including one-third of scleractinian corals. In contrast to human population size estimates, our quantitative understanding of status and trends in abundance is highly limited for most taxa. This is particularly true for corals. Their vast geographic range and population sizes entail inevitable trade-offs between taxonomic and spatial resolution. Data on species-level abundances is therefore scarce, geographically biased towards well-studied reefs and species and not readily collatable for meta-analyses due to inconsistencies in sampling design. This study provides for the first time, census population size estimates for more than 300 scleractinian corals at a longitudinal scale of 10,000km (Indonesia to French Polynesia). Estimates are calculated using species-level abundance data from a single, hierarchically structured (fringing reefs in 5 regions, 3 islands, 4 sites, 3 habitats: reef flat, slope and crest) and methodologically consistent dataset and corresponding regional estimates of reef area. This first large-scale quantitative account of scleractinian abundances will significantly advance our understanding of their conservation status and coral population biology in general. Recent estimates of global tree density illustrate the informative value of providing quantitative reference frames for global biodiversity.

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NUCLEAR BOMBS AND CORAL: GUAM CORAL CORE REVEALS OPERATION-SPECIFIC RADIOCARBON SIGNALS FROM THE PACIFIC PROVING GROUNDS (Abstract ID: 27966 | Poster ID: 9)

Radiocarbon (14C) analyses on a coral core extracted from the western Central Pacific (Guam) has revealed a series of early peaks in the marine bomb 14C record. The typical marine bomb 14C signal, one that is phase lagged and attenuated relative to atmospheric bomb 14C, is present in the coral core and is consistent with other North Pacific records. However, 14C levels that are well above what can be explained by air-sea diffusion alone punctuate this pattern. This anomaly has been demonstrated to a limited extent in other coral cores of the Indo-Pacific region, but is unmatched relative to the magnitude and temporal resolution recorded in the Guam coral core. Other records have shown an early Δ14C rise on the order of 40-50‰ above pre-bomb levels, with a subsequent decline before continuing the gradual Δ14C rise that is indicative of air-sea diffusion of 14CO2. The Guam coral Δ14C record provided three strong pulses in 1954-55, 1956-57, and 1958-59 that are superimposed on the pre-bomb to initial Δ14C rise from atmospheric bomb 14C. Each of these peaks can be directly linked to testing of thermonuclear devices in the Pacific Proving Grounds at Eniwetok and Bikini Atoll of the Marshall Islands. The measurable lag in reaching Guam can be tied to ocean surface currents and can be traced to other regional Δ14C records from corals, providing a transport timeline to places as distant as the Indonesian throughflow, Okinawa and Palmyra. These observations were validated with surface current modeling.
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NEW CHALLENGES FACED BY DOMINANT CORALS IN HONG KONG MARGINAL CORAL COMMUNITIES (Abstract ID: 29360)

The marginal coral communities in Hong Kong are dominated by a few species. Notable of these is *Platygyra acuta* which dominates many of the communities in NE Hong Kong. Studies conducted over the years have focused on the question "what makes it dominant". Experimental results have shown it to possess some dominant characteristics, including competitive aggressiveness and high tolerance to several environmental stresses, like elevated sea water temperature, lowered salinity ad high nutrients. On the other hand, it being very slow growing with very low recruitment rate appears to compromise these advantages. Recently, it is also shown to be very prone to sea urchin attack and sensitive to diseases, with the latter being associated with eutrophication and harmful algal bloom. Environmental changes brought about either by global climate change or anthropogenic activities are likely to erode the competitive advantages of *P. acuta*. With dominant species becoming less dominant, there could be significant implications on structural changes in Hong Kong coral communities. This project is supported by RGC GRF 14122215.

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IS THE STATUS OF CURRENT BENTHIC CORAL REEF COMMUNITIES OF SAUDI ARABIA LINKED TO ENVIRONMENTAL PARAMETERS? (Abstract ID: 30128 | Poster ID: 56)

Chemical and physical characteristics of marine environments are important factors shaping coral reef communities. The Red Sea, which extends from around 27° N to 13° N, shows significant gradients in the chemical and physical conditions, establishing boundaries for species populations and transitions in benthic communities. Accordingly, early surveys of the 1990s found differences in Scleractinia-dominated benthic communities along a north-south gradient, separating three faunistic zones. However, the latitudinal transitions of benthic coral reef communities have recently been questioned for Saudi Arabian Red Sea Coral reefs as temporal shifts and geographic homogenization of the benthic communities were observed. Benthic ecosystem alteration over time caused by environmental change and ongoing regional degradation by coastal development were suggested. Here, we present results of coral reef assemblages from the northern (Duba), central (Thuwal, Jeddah) and southern (Al Lith, Farasan Islands) Saudi Arabian Red Sea. Coral reef surveys were conducted between 2014 and 2016 using photo quadrate-transects at 2-5m and 10m depths. We investigate whether a homogenization of Scleractinia communities prevails over the apparent gradients of salinity, temperature, nutrients and primary production. The status and differences in coral reef communities were assessed and compared with local water parameters (phosphate, nitrate, chlorophyll a, and temperature). The results are being discussed in the context of potential factors driving the spatial coral reef community patterns.

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ABUNDANCE PATTERNS OF CORAL-DEPENDENT REEF FISHES IN SELECT SITES IN THE PHILIPPINES (Abstract ID: 29099)

Abundance and species diversity of coral-dependent fishes are affected by coral cover and so are often used as indicators of coral reef health. The community structure of coral-dependent reef fishes in relation to the benthic composition was analyzed for

at least 17 municipalities in the Philippines. Fish abundances were obtained through underwater fish visual census (n≥6 50-meter transects per municipality). Benthic cover was obtained using photo transect method along the same transects. At least 80 species from seven families (Chaeototidae, Pomacanthidae, Pomacentridae, Labridae, Apogonidae, Zanclidae, Serranidae subfamily Anthiinae) were observed in the sites. Abundances of coral-dependent fish were generally low, except for small pomacentrids Chromis ternatensis and Dascyllus reticulatus that shelter in branching Acropora and Pocillopora. Some sites had very similar benthic cover but had the most dissimilar adult fish community (e.g. Lian and Sablayan), which could be attributed to extensive fishing for the aquarium trade. Most aquarium fishes are coral-dependent and there are 10-15 reported aquarium fishers in Lian. Juvenile recruitment appeared to be similar across the municipalities. This study shows that other factors, such as threats from fishing, should be used in combination with the abundance and species diversity of coral-dependent fish in assessing coral reef health, and that the aquarium fish trade may have a large impact on fish community structure.

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SUPPORTING SMART CHOICES FOR CORAL REEF MANAGEMENT AND POLICY IN A CHANGING WORLD (Abstract ID: 28870)

Climate change, global and regional economic flux, human populations, and coastal and urban developments are among the many forces influencing the status and trend of coral reefs. Decision problems on coral reefs are multi-faceted issues influenced by local and global cumulative impacts within linked social-ecological systems. For coral reef managers and policy makers to make informed decisions in this complex setting, tools are required that improve clarity of issues, options, risks and the consequences of actions. The purpose of this talk is to paint a picture of how decision science, specifically a structured decision-making approach, can provide such clarity. We use (1) coastal development projects, (2) land-use management, and (3) control of Crown of Thorns Starfish (COTS) as examples to illustrate the key elements of a structured decision process. We demonstrate the role of models in informing and predicting consequences and their uncertainty. We provide a case study for the Great Barrier Reef to illustrate how multiple objectives (environmental, social and economic), pressures (e.g. climate change, water quality, COTS) and scales (local, regional, global) can be broken down into clear and tangible decision problems. Although global drivers are not under the direct control of reef managers, understanding their influence on the system can guide efforts to alleviate interacting local-scale effects and in setting realistic goals for regional-scale management strategies. http://www.aims.gov.au

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CARBON ABSORPTION AT TRANSPLATATION OF CORAL REEFS IN NIRWANA BEACH, PADANG, WEST SUMATRA, INDONESIA (Abstract ID: 28814)

ABSTRACT Coral reefs is one of the most important ecosystems in the sea. Coral reefs not only provide place for feeding but also capable of carbon absorption in skeleton. This research was conducted on June 2014 in the area of transplantation of coral reefs in coastal waters, Nirwana Beach Padang, West Sumatra, Indonesia. This study aimed to see the amount of carbon stored in three species of coral reefs. The Three species of coral are Acropora formosa, Acropora millepora, Acropora humilis that transplanted during the six months sampled and measured the amount of carbon stored in coral skeletons using techniques Spectrofotometry. The results from this study show the carbon sequestered in the coral skeleton Each of these coral species in this study have different absorption, the absorption of the highest in this study is Acropora humilis. Keyword: Coral Reefs, Carbon, Coral Transplantation

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SEASONAL VARIABILITY OF MESOPHOTIC BENTHIC COMMUNITIES AT TWO SITES AND DEPTHS OFF LA PARGUERA, PUERTO RICO (Abstract ID: 29778)

Coral reefs are dynamic environments, and rapid changes in benthic cover can occur in response to environmental conditions or biological interactions. Mesophotic coral ecosystems are thought to be more stable than shallow coral reefs because it is assumed that variations in environmental parameters (e.g., temperature) are reduced at depth, and MCEs are buffered by depth or distance from shore from surface-based disturbances. We investigated changes in percent benthic cover at quarterly intervals over one year at two mesophotic sites along the insular slope: El Hoyo (low rugosity, low slope) and Hole-in-the-Wall (high rugosity, high slope). Data were obtained from two replicate high-resolution phototransects conducted at each of two depths (50, 70 m) at each site. Nonmetric multidimensional scaling showed that site and depth combinations tended to cluster separately, with individual transects within site/depth typically having less than 80% but greater than 60% similarity over space and time. Temporal trends were similar across sites and depths. Dominant changes occurred among the algae, particularly *Dictyota* and *Schizothrix*, with the former oscillating from near 0 to over 30% cover, peaking in March and September. The latter species showed a general increase over time. The magnitude of change was higher at 50 m. The degree and magnitude of variability at mesophotic depths was less than previously documented at 30m depth. While temporal variability declines with depth, relative impacts must account for potential reductions in productivity as well.

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UNRAVELING THE COMPLEXITY OF THE CORAL MICROBIOME: DESCRIPTIONS OF PUTATIVE AND CONFIRMED ENDOSYMBIONTS (Abstract ID: 28195)

Corals engage in relationships with prokaryotic microorganisms which are thought to play important roles in coral health. However, the significance or role of most prokaryotic endosymbionts in corals has remained elusive, and this is partially attributed to the complexity of the prokaryotic communities within the biogeochemically diverse mucus, tissue and skeletal microenvironments of corals. Here we present small subunit ribosomal DNA gene-based sequencing data of bacteria and archaea from decalcified coral tissues of common Caribbean and Pacific corals which demonstrates that corals do harbor specific tissue-associated, putative endosymbiotic bacteria and archaea. In some cases, we utilized specific probes with fluorescent in situ hybridization and microscopy to visualize and localize these cells within the tissues of the coral, thereby confirming their endosymbiotic nature. We will describe the location of these endosymbionts in corals, the potential significance of these relationships, and our ongoing efforts to elucidate the functional interactions between prokaryotic cells and the coral holobiont.

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GENOME ANALYSIS OF CORAL DINOFLAGELLATE SYMBIONTS HIGHLIGHTS EVOLUTIONARY ADAPTATIONS TO A SYMBIOTIC LIFESTYLE (Abstract ID: 28676)

Members of the genus Symbiodinium, best known for their ability to form symbiotic

relationships with scleractinian corals, harbor among the smallest dinoflagellate genomes providing an opportunity to interrogate genomic evolution and endosymbiosis in this enigmatic group of protists. We sequenced the genome of Symbiodinium microadriaticum (clade A1) and compared it to the available genome of Symbiodinium minutum (clade B1) and transcriptomes from other dinoflagellates. Despite a conserved preference for non-canonical splice-sites, unidirectional gene arrangement, and a paucity of regulatory upstream motifs, both genomes showed an unexpected degree of genomic divergence. Comparative analyses of the encoded protein sets revealed a strong enrichment of transmembrane transporters involved in the exchange of nutrients in dinoflagellates. Importantly, we find that Symbiodinium, in contrast to other dinoflagellates, have evolved an extensive repertoire of bicarbonate transporters and carbonic anhydrases to ensure provision of CO2 for photosynthesis, as well as ammonium transporters to counter nitrogen limitation, possibly to evade growth control by the host. Phylogenetic analyses of these transporters suggest lineage-specific expansions that imply stark physiological differences between species that may define differences in host compatibility. Our results unravel several genomic aspects underlying the ecological success of dinoflagellates, and highlight the importance of gene duplications as an evolutionary mechanism for adaptation in dinoflagellates and Symbiodinium.

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UNDERSTANDING PHILIPPINE REEF FISH DIVERSITY AMIDST RISING THREATS AND MANAGEMENT EFFORTS (Abstract ID: 29458)

The Philippines is part of the global epicenter of marine biodiversity but our knowledge on the state of its own marine biodiversity remains incomplete. Biodiversity assessments have been few, especially since they require large resources for sample collections. This gap is critical because of the urgency to improve conservation amidst rising threats. Here, we used information from underwater visual census to study reef fish diversity trends (i.e. species richness and species diversity). Data collected from 1991 to 2015 in over 2,200 transects and 167 cities/municipalities were used to assess spatio-temporal trends in diversity and to identify potential hotspots for reef fishes in the country. Information on the current protection status of the different sites was also used to determine priority conservation areas. Initial analyses show that most sites have low to moderate levels of species richness and diversity despite the presence of marine protected areas (MPAs) although species richness has remained high in other areas even without clear management initiatives. The study explores the role of both natural ecological processes and exposure to threats on the observed patterns of diversity in Philippine reef fishes. The need to complement protection efforts with other fisheries management strategies to address overexploitation and destructive fishing practices is also highlighted. Facilitating conservation issues are put into context with their strategic relevance and implementation.

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LEVELS AND DRIVERS OF COMPLIANCE WITH MARINE PROTECTED AREAS (Abstract ID: 29921)

Marine protected areas (MPAs) are widely used tools for marine conservation and fisheries management. Compliance alone is a strong predictor of fish biomass within MPAs. Hence, fishers' compliance is critical for MPA effectiveness. However, there are few studies looking into compliance with MPAs. Without such information, practitioners have limited opportunities to provide effective interventions. The effectiveness of MPAs relies largely on users' compliance, particularly from fishers, because fishing can profoundly degrade global marine biodiversity and ecosystems. The mere presence of an MPA does not guarantee fishers' compliance, and its effectiveness can be eroded by illegal fishing. Indeed, the ecological performance of MPAs has been linked to fishers' compliance. In this talk I explore the levels and drivers of fishers' compliance with MPAs. By studying 12 coastal MPAs in Costa Rica, I investigate the roles of different variables in influencing fishers' compliance. Compliance levels were higher in MPAs: (1) with multiple livelihoods, (2) where government efforts against illegal fishing were perceived to be effective, (3) where fishing was allowed but regulated, (4) where people were more involved in decisions, and (5) that were smaller. I also provide a novel and practical measure of compliance: a variable formed by the number of illegal fishers and the frequency of illegal fishing. I underline the centrality of people's behavior in nature conservation, and the importance of grounding decision-making on the social and institutional realities of each location.

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CONTROLS ON REEF DEGRADATION AND RECOVERY (Abstract ID: 28058)

Reef frameworks in the western Atlantic and eastern Pacific record the millennial-scale persistence of dominant coral species. These coral populations were at times disrupted by the direct and indirect impacts of climate change, and by other large-scale perturbations. If macroalgae dominated these reefs in the past, that dominance would have been a consequence rather than a cause of coral mortality. At annual to decadal scales, contemporary coral and macroalgal dynamics appear to be decoupled in the absence of external drivers, whether the cover of living coral is low or high. Macroalgal cover tends to fluctuate in a complementary fashion with CTB (crustose coralline algae, fine algal turfs, and bare space), independent of coral cover. When modern coral populations are killed, the space opened may or may not be colonized by macroalgae; macroalgal dominance, when it occurs, is again a consequence rather than a cause of coral mortality. Macroalgal cover may be either dependent on or independent of levels of herbivory by sea urchins and, in some cases, herbivorous fish. The future trajectories of many coral populations will likely be driven primarily by climate change, in which case enhancing herbivory might provide partial help as a management strategy. However, overemphasizing local issues such as the abundance of parrotfish will not save coral reefs.

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GENETIC STRUCTURE OF BICOLOR DAMSELFISH IN CAMPECHE BANK CORAL REEFS (MEXICO) (Abstract ID: 29863 | Poster ID: 193)

Long term ecosystem resilience is related to the degree of connectivity present within and between populations. We studied genetic connectivity (gene flow) indirectly through allele frequency analysis. We sampled bicolor damselfish (Stegastes partitus)-a small territorial demersal fish- to study dispersal. Dispersal occurs exclusively during the pelagic larval phase (PLD = 28 days). In order to study genetic connectivity in ecological time scales, we sampled recruits and used microsatellites as molecular markers. Three reefs were sampled: Cay Arenas, Cay Arcas, and the Alacranes atoll, wich are separated by 200 - 350 kilometers. The project consisted of PCR, genotyping in an automated sequencer, and computer analysis of the allele frequencies observed. Several methodologies were used to analyze the data. We quantified genetic diversity, and evaluated genetic structure using: private alleles, traditional hierarchical coefficients (Gst, Rst, global and pairwise), AMOVA, genetic distance measures, J'ost D, PCoa, cluster assignment tests, and network analysis. Results showed weak genetic structure thereby low levels of gene flow between sites. The genetic composition of recruits showed some similarities between sampling sites, suggesting that even though there's genetic heterogeneity in the system, recruits have the capacity to disperse between the three reefs sampled. The degree and manner in wich the genetic diversity is distributed among coral reefs is important in the elucidation of the scale of connectivity in reefs, both for basic science and conservation planning.

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PHYLOGENY AND EVOLUTION OF THE CORAL FAMILY LOBOPHYLLIIDAE (Abstract ID: 28618)

The family Lobophylliidae is a widespread and ecologically important group of scleractinian corals. It is undergoing a major taxonomic revision thanks to the combination of molecular phylogeny reconstructions and novel morphological data. In this study we examine specimens of many different lobophylliid genera and species collected from numerous localities throughout the Indo-Pacific and the Red Sea. Sequencing of several molecular loci (both nuclear and mitochondrial DNA) is combined with detailed exami-

nation of skeletons at macromorphologcial, micromorphological, and microstructural scales. Phylogenetic relationships among taxa within the Lobophylliidae are proposed and discussed in an evolutionary framework. Molecular and morphological datasets are mostly in agreement and allow the discovery of new species in the genera*Acanthastrea*, *Echinophyllia*, and *Lobophyllia*, whereas some taxa, erroneously synonymized with other ones, are resurrected. In one case, a deep genetic divergence does not reflect a morphological distinction, allowing the discovery of a new cryptic genus from the Indian Ocean and the Red Sea. The obtained data represent a considerable improvement in the understanding of the evolution of this coral family and reveal hidden biodiversity and unexpected biogeographical patterns.

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RESOURCE USE, INCIDENTAL RESILIENCE AND THE DANGERS OF ACCIDENTAL CONSERVATION IN THE LAKSHADWEEP REEFS (Abstract ID: 28562)

While identifying the last pristine reef refugia in a rapidly changing climate is critical, finding models to manage more typical reefs (with high resource-dependent human communities) is a more urgent imperative. The Lakshadweep Islands are a possible model reconciling livelihoods and reef resilience. We tracked reef responses to repeated bleaching events since 1998, documenting considerable resilience, due to high herbivory, high predator density, and adequate settlement areas. This resilience is an unplanned consequence of a fisheries programme in the 1980s to promote a pelagic tuna fishery. Tuna quickly replaced reef fish as the dominant fishery with epiphenomenal reef resilience benefits. However, responding to new markets, fishers have, since 2010, begun to exploit reef fish once again. This return to reef fishing is characterised by a qualitative shift in the relationship fishers have with the reef. While past reef fishing was for domestic consumption, the majority of the catch today supplies international markets, exploited merely as an economic commodity. Our studies further show that with two generations of disuse, traditional institutions of resource control no longer exist across the archipelago. Without these restrictions, after 4 years of fishing, we documented major declines in the many target groups. This threatens to unravel the resilience the reefs currently possess. While the Lakshadweep case study is a possible model of a workable win-win solution, it is a cautionary tale of the potential dangers accidental conservation interventions can hold.

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LOW SCLERACTINIAN CORAL DENSITY IS ASSOCIATED WITH INCREASED DENSITY OF A COMMON REEF FISH PARASITE (Abstract ID: 29823)

Live scleractinian coral cover is declining worldwide. While loss of stony coral cover is positively associated with decreasing fish diversity and abundance, the effects on smaller reef organisms are less-well studied. Gnathiid isopods are small external parasites that feed on the blood of a wide range of host fish species. Unlike many external parasites, they associate with hosts temporarily, spending most of their lives in benthic substrate. In spite of their impact on hosts and ecological importance, little is known about the factors that influence their distribution and abundance on coral reefs. We quantified the density of the Caribbean gnathiid, Gnathia marleyi using light traps deployed on shallow reefs in the US Virgin Islands, and characterized the benthic habitat and fish communities associated with each sample. Among the twelve variables examined, live coral cover was the best predictor of gnathiid density, with gnathiid density increasing with decreasing coral cover. Gnathiid density was negatively correlated with daytime fish abundance, but positively correlated with nighttime fish abundance. In a parallel study using fish-baited traps in the central Philippines, live coral was also a significant predictor of overall gnathiid density. These findings corroborate laboratory studies showing that gnathiids avoid and are consumed by live coral and suggest that live stony coral or a close associate may be a limiting factor in gnathiid density. Live coral may thus serve as a refuge from parasitism for reef fishes.

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DELINEATING PRIORITY AREAS FOR MARINE BIODIVERSITY CONSERVATION IN THE CORAL TRIANGLE. (Abstract ID: 28278)

A challenge in implementing marine biodiversity conservation is in identifying representative networks for biodiversity protection with standardized and consistent criteria. Here we developed a concise set of ecological and biological criteria of identifying areas significant for biodiversity conservation. Four criteria were based on habitat characteristics and another four based on species' feature. To assess these criteria, We propose five key biodiversity variables: habitat cover, species attributes, species richness, geographic range and population abundance. We used data derived from open-access biodiversity informatics databases and applied our framework to the Coral Triangle region. We used a modelled geographic distribution of 12,783 species to map species richness, and 39,452 points of occurrence of 1,742 species to generate distribution maps of threatened species. The coverage of biogenic habitats (i.e. coral reefs, seagrass and mangrove forests) was used to assess the habitat distribution. Spatial analysis and multi-criteria evaluation were developed to objectively and systematically prioritise areas with high biodiversity conservation values. We found that ecoregions of Papua, Eastern Philippines, Halmahera, Banda Sea and Salomon Sea were the high priority areas for biodiversity conservation. The criteria and key biodiversity variables proposed here are a potential tool to facilitate the identification of additional important areas for marine biodiversity and contribute to minimizing gaps in ecological representativeness within the protected areas networks.

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ROVING PREDATORS RELOADED: AN INVESTIGATION OF SHARK AND JACK POPULATIONS IN SHALLOW (0-30M) AND MESOPHOTIC DEPTHS (30-100M) IN THE HAWAIIAN ARCHIPELAGO (Abstract ID: 28880)

Coral reef roving predators (sharks, jacks, snappers) are generally believed to be depleted around human population centers. In Hawaii, most of the data to support this conclusion comes from underwater visual censuses of shallow water reef ecosystems (0-30m). However, information on the density and distribution of mobile predators in mesophotic depths (30-100m+) remains sparse. Survey techniques suitable for mesophotic surveys (e.g. technical dive surveys, submersibles) tend to be expensive, logistically challenging, or may only cover a relatively small number of sites per day. A simple, low-cost alternative approach suitable for a wide range of depths is the use of baited remote underwater stereo-video systems (stereo-BRUVs). Between 2012–2014, we deployed stereo-BRUVs to assess roving predator populations around the main Hawaiian Islands (MHI; Maui, Lanai, Molokai, Oahu) and the Northwestern Hawaiian Islands (NWHI; French Frigate Shoals, Lisianski Island/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll), targeting sites previously surveyed by divers (0-30m), along with mesophotic sites (30-100m). Stereo-BRUVs surveys found several species of roving predators are significantly more abundant in mesophotic habitats than in shallow habitats. Although results corroborate diver surveys that roving predators are much more abundant in the remote NWHI than in the populated MHI, the greater depth coverage and diver independent nature of stereo-BRUVs surveys provides much more information and more accurate estimates of relative abundance than was previously available.

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HELIOPORA PHASE SHIFT ON A PHILIPPINE CORAL REEF? (Abstract ID: 29710)

Ecological shifts in the face of climate change have usually been discussed in the context of algal-coral phase shifts particularly as a consequence of ocean acidification and thermal anomalies. Our observation of the reef in Bolinao is different from what has been widely proposed in the literature. Algal cover has remained low when compared to the suggested threshold of an algal-phase shift. In this paper we propose a different ecological shift, which may be considered an intermediate phase towards an algal-coral phase shift. A Heliopora phase shift and the mechanism is different from what has been proposed for algal phase shift. While coral-algal phase shifts are associated with the loss of top-down control mechanisms such as overfishing and others like soft corals and sponges shifts are implicated to bottom-up dynamics, Heliopora phase shift is driven by a different mechanism, the warming of sea water as confirmed by laboratory experiments, which induced an aggressive growth of this coral. H. coerulea has changed the bottom cover and community structure of a Bolinao Reef, Northwestern Philippines. We suspect this to be caused by the long-term increase of sea surface temperature in the West Philippine Sea region by approximately 2oC during the past two decades.

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PROTECTING THE LONG TERM HEALTH OF THE GREAT BARRIER REEF

THROUGH RESTORATION AND ENHANCEMENT OF ADJACENT COASTAL ECOSYSTEMS (Abstract ID: 28624)

The health and resilience of the Great Barrier Reef are critically dependent on the catchment's coastal ecosystems and the quality of water discharged from the catchment. In the past, little regard has been given to the role coastal ecosystems in the catchment have on the health of the Great Barrier Reef. It is estimated that approximately 40% of remnant vegetation in the Great Barrier Reef catchment had been cleared by 2009, and 74% of the catchment was used for grazing. Of the 424,000km2 that makes up the Great Barrier Reef catchment less than 10% is protected as National Park. Much of the ecological services of the Great Barrier Reef catchment have been lost or heavily modified and this is reflected in the declining health of the Great Barrier Reef, particularly inshore areas. Today there is an increased public appreciation for the influence the catchment has on the receiving waters of the Great Barrier Reef and its biodiversity. The Great Barrier Reef Marine Park Authority places considerable importance on a coordinated and collaborative approach to the management of the catchment and Reef. The Authority has collaboratively developed a set of principles and decision-making tools to assist natural resource managers, decision makers, landowners and managers, to enable them to restore, maintain or enhance the environmental values and ecological functions of coastal ecosystems to support the long-term health of the Great Barrier Reef.

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SKELETON ULTRASTRUCTURE OF CORALLINE RED ALGAE MIRRORS MOLECULAR BIOLOGICAL PHYLOGENY (Abstract ID: 28281)

Coralline red algae are calcifying, globally occurring algae well suited for ecological and climatological studies. Classification mainly focuses on the soft tissue anatomy of their reproductive cavities, secondary connections between filament cells (secondary pit connections or cell fusions) and the existence of genicula. Contrary to morphologically based taxonomy molecular studies suggest that except conceptacle characters none of the common features used are diagnostic for specific families, creating often paraphyletic and polyphyletic morphological clades. SEM analyses of epithallial cells, meristem cells and the vegetative thallus show that the calcite crystallites formed within the polysaccharide matrix of the corallinacean cell walls are taxon specific. This analysis is based on a global sample set including the genera *Phymatolithon, Lithothamnion, Lithophyllum, Titanoderma, Spongites, Porolithon, Hydrolithon, Neogoniolithon, Mastophora* and *Sporolithon*. While it is generally assumed that epithallial cells roofs do not calcify, our results show that they fully calcify in nearly all genera and the calcite crystallites have distinct genus specific shapes. Together with the cell wall crystallites, these epithallial crystals can thus be used as a taxonomic tool on at least a generic level and, thus, offer to be a powerful morphological tool for the classification of calcareous red algae. Furthermore, a comparison of the observed ultrastructure morphology with phylogenetic trees based on molecular data of extant coralline red algae shows a clear match.

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EFFECTS OF SCHOOLING AND HABITAT CONFIGURATION ON THE BEHAVIOR OF PARROTFISH TOWARDS PREDATORS (Abstract ID: 28122)

Predation risk has been shown to inhibit locally the foraging activities of roving herbivores, but the effects of predator identity, schooling, and habitat configuration on the behavior and microhabitat selection of herbivores has not been directly tested. We examined the behaviors of solitary and schooling juvenile parrotfish in the presence of either a grouper (ambush predator) or snapper (roving predator) and without predators. Fishes were filmed in 2x2 $m^2$ tanks containing artificial microhabitats (i.e., branching coral, massive coral, and rubble) arranged in six different configurations such that each microhabitat type varied in their degree of contiguity. We determined the microhabitat preference of parrotfish for foraging and refuge. We found that the anti-predator responses of parrotfish were stronger towards snapper than grouper, often resulting in parrotfish hiding under corals at the expense of foraging, especially when rubble patches are contiguous. Schooling mitigated the predation risk effect of snapper although the foraging rate of focal parrotfish was still lower than when predators were absent. Parrotfish did not show significant microhabitat selection in the absence of predators but preferred to forage on rubble in the presence of either predator. Results show that predation risk effects are dependent on predator identity, presence of conspecifics, and habitat configuration. Microhabitat use was context-dependent and such fine-scale decisions may be important in determining the grazing patterns of parrotfish.

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CORAL REEF OF SARAWAK, BORNEO (Abstract ID: 27877 | Poster ID: 79)

Sarawak is one of the biggest state in Malaysia, located between the latitude 0° 50'and 5'N and longitude 109° 36' and 115 ° 40'E. Sarawak has the second longest coastline 1051km in Malaysia, thus the EEZ of Sarawak occupies the southern part of the South China Sea with an area of 160,000 km² (area 124,449.5 sq km). The coral reef biodiversity was studied from 2004 to 2015. The aim was to collect baseline data on the corals and coral associated living resources. Study area were divided into four areas, Kuching, Bintulu to Miri, Luconia and Lawas. Most of the coral reefs in Sarawak are found offshore, with the depth more than 18m and geographically patchy.
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LEADERSHIP IN HAWAI'I CORAL REEF FISHERIES (Abstract ID: 29901)

Leadership is often touted as a solution to fisheries and coral reefs management problems. However, most leadership research exhibits an embedded normative bias and skews analysis towards the individual. Further, few studies observe leadership as a construct or empirically examine its component parts. Here, leadership is observed in the context of coral reef fisheries co-management in the main Hawaiian Islands. In Hawai'i, an institutional pathway allows communities to partner with the State of Hawai'i to co-manage coral reef fisheries. However, few successful partnerships have emerged in the past 25 years despite enabling legislation, a set of highly motivated communities, significant NGO and foundation support, and seemingly a multitude of local leaders. To investigate local leadership in Hawai'i coral reef fisheries, 45 interviews were conducted over three years with individuals from NGOs, academia, government, and fishing communities across Hawai'i. Respondents were asked about the importance of leadership in the context of co-management, and other leadership components derived from the academic literature. Although respondents offered some diverse viewpoints, there was general agreement that leadership functioned well when local leaders acted as facilitators or organizers and possessed a wide network of relationships. These findings support the conceptualization of leadership as a process in coral reef fisheries. Findings from this paper should contribute to better understanding of effective local level leadership in coral reef fisheries co-management.

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ASSESSING REEF FISH RESILIENCY AND PRODUCTIVITY IN THE PHILIPPINES (Abstract ID: 29123 | Poster ID: 576)

The Coral Reef Visualization and Assessment (CoRVA) Program – Reef Fish Resiliency and Productivity (Project 3) is a nationwide effort initiated by the Biodiversity Management Bureau of the Department of Environment and Natural Resources (BMB-DENR), to assess the existing reef fish community status in the Philippines. The project aims to evaluate the resilience and productivity of reef fish communities in selected National Integrated Protected Areas System (NIPAS) sites and within Verde Island Passage (VIP) which is designated as an important biodiversity corridor. The undertaking employed intensive collection of reef fish community and biological data deemed important in providing insights on the relative resilience of reef fishes. Information generated from the project is expected to contribute in the preparation of important management strategies necessary to ensure reproductive success, habitat health, and sustainability of reef fisheries in the country. The project integrates current information on adult community and trophic structure; reef fish recruitment and habitat association; and age at first sexual maturity of selected iconic reef fishes to obtain a better perspective on the present state of reef fish communities in specially managed sites across the country. In the first year of its implementation, both trainings and assessments have been conducted in four NIPAS sites and in VIP. The results showed that the relative resilience of reef fish species varied across sites; and within these sites, differences were also observed between managed and open access reefs.
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EFFECT OF BOOSTER BIOCIDES, IRGAROL ON CORALS FROM MALAYSIAN REEF, SOUTH CHINA SEA, AS INDICATE BY FATTY ACID MARKERS (Abstract ID: 27971)

Changes of fatty acid composition in the reef building coral Galaxea fascicularis that was exposed to the boster biocide, Irgarol 1051 was determined. Laboratory exposure experiments evidenced that Irgarol 1051 have significant impact on fatty acid composition of the coral even if exposed at the low levels of this biocide. Healthy G. fascicularis from Bidong Island, Malaysia had higher fatty acids profile compared to its non-healthy. The results showed that, fresh and control samples of G. fascicularis were dominated by polyunsaturated fatty acids, and the mean concentration of these fatty acid significantly decreased after the coral was exposed to the biocide ($p< 0.05$). It is proven that corals that exposed by Irgarol 1051 have significantly higher concentration of monounsaturated fatty acids ($p< 0.05$), might due to the colonization of bacteria on the dead parts of the coral. The present findings demonstrate that Irgarol 1051 threatens the health of corals due to changes of fatty acids composition of G. fascicularis and may have implications on metabolisms of the corals.
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CORAL BLEACHING EVENTS IN KANEOHE BAY, OAHU HI: WHAT HAVE WE LEARNED? (Abstract ID: 28807)

The occurrence and severity of mass coral bleaching has increased dramatically over the last two decades with almost every reef region in the world suffering extensive bleaching and mortality. The first coral bleaching event in Kaneohe Bay occurred during 1996 and was followed by more severe events in 2014 and 2015. Generalizations based on the 1996 event did not hold during the 2014 event. Likewise, the patterns observed in 2014 diverged from what we thought was learned from the previous two events. The unexpected patterns of bleaching and mortality were due to a number of factors including: 1. Localized patterns of water circulation, 2. Variation in irradiance due to different patterns of cloud cover and temporal variation in turbidity, 3. Differences due to seasonal timing and duration of the warm water event, 4. Influence of localized fresh water flood events interacting with temperature bleaching, 5. A shift in species sensitivity in the abundant coral *Montipora capitata* as well as minor changes in species composition (e.g. reduction in *Pocillopora damicornis* and elimination of *Montipora dilitata* ) due to high temperature. The reefs of Kaneohe Bay have shown remarkable resilience to a wide variety of natural and anthropogenic insults over the centuries, but the pressing new question centers on whether coral reefs can survive under continuously increasing temperature and ocean acidification along with changes in sea level, precipitation and more severe storm activity predicted under climate change models.

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PATTERNS OF CORAL BLEACHING IN AMERICAN SAMOA (Abstract ID: 28835 | Poster ID: 353)

The ongoing global coral bleaching event began in the North Pacific in the summer of 2014 and expanded to the South Pacific and Indian Oceans in 2015. The NOAA Coral Reef Watch outlook indicates it is likely to continue well into 2016. An ecosystem-scale assessment of coral populations in American Sāmoa from February to March 2015 provides crucial information about the distribution and abundance of corals and the prevalence of bleaching at multiple spatial scales to affected genera and species. A two-stage stratified random sampling design was employed to survey 188 sites across 5 islands/atolls: Ofu-Olosega, Rose, Swains, Ta'ū, and Tutuila. The stratification scheme incorporated island sectors, three reef zones (fore reef, back reef, and lagoon), and three depth categories (0–6 m, >6–18 m, and >18–30 m), where present. Coral abundance, size, partial mortality, condition (e.g. bleaching) were surveyed within two 10-m2 belt transects per site. Population prevalence of bleaching for all scleractinian corals combined was 5.47% (SE 0.61%), ranging from 66.04% to 0% among genera, and from 66.67% to 0% among selected species. The most affected genera include Isopora, Montastraea, Leptoseris, Fungia, Pavona, Pocillopora, and Porites. Bleaching prevalence varied across islands/atolls, strata, genera, and species. These results provide a quantitative assessment of bleaching patterns across habitat space, genera, and species during the survey period. In addition, the spatial pattern of bleaching identifies potentially vulnerable and resilient reefs in American Sāmoa.

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SPECIES BOUNDARIES IN TABULAR ACROPORA SPECIES IN OKINAWA (Abstract ID: 29103)

The molecular revolution has greatly increased our understanding of evolutionary relationships in the Scleractinia, however, in some taxa, such as the genus Acropora, molecular markers for distinguishing species have yet to be developed. Consequently, progress in establishing species boundaries in these genera will require alternative approaches, such as detailed observations of the timing of reproductive events and cross-breeding trials. Here, we used gross morphology, morphometrics, breeding trials and six molecular markers to explore the species boundaries in the tabular Acropora species complex in Okinawa. Gross morphology suggests at least 4 different groups, morphometric analyses suggest two to four groups, breeding trials suggest two or three groups, however, the two molecular markers analysed to date suggest that all 24 colonies belong to one species. The most likely explanation for these patterns is that rare hybridization events homogenise the gene pools of groups that are otherwise biologically and morphologically distinct. We conclude that a number of lines of evidence are required to establish species boundaries in corals and the boundaries chosen will depend on the question of interest.

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COMMUNITY PARTICIPATION IN THE MARINE PROTECTED AREA (MPA) ESTABLISHMENT PROCESS IN INDONESIA: ITS OPPORTUNITIES AND CHALLENGES (Abstract ID: 27874 | Poster ID: 665)

MPA legislation in Indonesia includes provision for community involvement in the establishment of MPA.This research examined participation in the MPA legislation and the extent to which the establishment of MPA has become more democratic and decentralized.Research sites were selected based on different levels of MPA;they are:national-level MPA at Savu Sea,district MPA at Derawan,and village no-take areas at Pangkep.It was found that MPA legislation provides opportunities for communities to be informed and consulted in the establishment process.However,this falls short of the active participation that is required in order for MPAs to be successful.Field research results showed that complex web of legislation from different levels of government influenced the participation.Gaps in legislation and mismatches with other national legislation have meant that legislation is only applied for national-level MPAs.However,no provision for community involvement in their managements and thus,no incentive for communities to participate.Degree of participation depend on available budget.MPA establishment teams had to prioritize the use of limited funding that led to work with government agencies,whose support was needed to override mismatches in policies and legislation that might threaten the existence of MPAs.Consequently,community participation was considered a secondary priority.To enhance participation in the MPA,communities still rely heavily on government and NGOs to improve their capacity to participate meaningfully.Commitment from these stakeholders is required to build community capacity to play a leading role in the MPAs.

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MANIPULATION, INTRODUCTION, AND FATE OF THERMOTOLERANT ALGAL SYMBIONTS IN REEF-BUILDING CORALS (Abstract ID: 30023)

The ability of some reef corals to undergo changes in their algal symbiont communities in favor of thermotolerant *Symbiodinium* is one mechanism by which corals may survive bleaching events and persist into the future despite continued warming. To investigate the dynamics of these unusual symbionts we used a novel transplantation method to experimentally introduce thermotolerant symbionts into healthy corals. We used controlled bleaching at 32°C to remove the 'native' *Symbiodinium* C3 from replicate cores of the Caribbean coral *Montastraea cavernosa*, and recovered them at 29°C with thermotolerant symbionts (*Symbiodinium* D1a, aka *S. trenchi*). These 'stress hardened' cores no longer bleached when exposed to 32°C. We then reciprocally transplanted tissue plugs from these manipulated cores into control (unbleached) cores containing C3, and vice versa (N=20 pairs from 5 colonies). The fate of these introduced symbionts, measured in mini-transects across cores using quantitative PCR, was dependent on (1) temperature, with D1a displacing C3 within 3-6 months when maintained at 29°C , but C3 displacing D1a at 22°C; (2) the relative abundance of introduced vs. resident symbionts; and (3)

the type of symbiont introduced. As thermotolerant symbionts become more common on disturbed reefs worldwide, these findings help us understand their origin and spread, investigate their relative costs and benefits to reef ecosystems, and consider potential interventions to help reefs survive continued warming.
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MULTI-DECADE MONITORING OF REEF-BUILDING CORALS ON THE FLORIDA KEY REEF TRACT (Abstract ID: 28786)

The Florida Keys reef tract is a highly degraded ecosystem with low coral cover on most reefs, which has been attributed to warm-water bleaching, cold-weather events, coral diseases, and anthropogenic sources of nutrient influx. Using a data set that has been sampled seasonally for over 20 years, we look at tissue biomass, chlorophyll a content, maximum photosynthetic capacity of PSII (Fv/Fm), Symbiodinium density, and dominant Symbiodinium genotype of three reef-building coral species (Orbicella spp.) in the Florida Keys. Data has been collected during two of the three worldwide bleaching events and shows anomalies in coral biomass and Symbiodinium measurements. Biomass of deep and shallow reef-building corals had lowest biomass following the 1997-98 worldwide bleaching event but steadily increased and exceeded original biomass between 1998 and 2014. Interestingly, Symbiodinium density and chlorophyll a content have remained consistent despite an increase in tissue biomass. Fv/Fm initially decreased following the 1997-98 bleaching event but leveled out and have remained relatively constant. During 1997-98 and 2014-15 bleaching events Fv/Fm fell to extremely low values indicating that, like temperature, a Fv/Fm threshold may also exist. Long term monitoring of reef-building corals is key to understand how corals respond to environmental stress and their recovery over long periods of time.

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REEFS OF FUTURE PRESENT: HONG KONG CORALS FROM THE QING DYNASTY TO THE INFORMATION AGE (Abstract ID: 30014)

My geologist friends tell me that Hong Kong has no 'proper' coral reefs. This is because there is no evidence of carbonate formations upon which living corals are still found. Instead, corals grow on exposed bedrock in a patchy distribution and any exposed carbonates are quickly eroded away. Were there proper coral reefs in the past? Consider that during the Qing Dynasty the industrial production of slaked lime was extensive throughout Hong Kong, yielding 40 tons per year from mining living bivalve and coral communities. Indeed, historical records and archaeological evidence describe a very different environment in the past; where apex predators, megafauna, and diverse reef invertebrates were common. Through archeological digs, we show that the diversity and abundance of corals and other invertebrates declined markedly over the last century, including the extirpation of several coral species. We analyzed subtidal push cores to show that coral abundance has decreased by 50%, and coral fragment identification from sediments to delineate a 40% contraction in the range of important staghorn corals. Today, coral decline is closely linked to coastal development and pollution, which limits the recovery of coral communities. However, thanks to government efforts at improving water quality, we demonstrate that active restoration of coral communities is possible. Through targeted propagation and transplantation we show that staghorn corals have high rates of growth and survivorship in areas where they were previously eliminated giving hope to the future of these marginal reefs.
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DETERMINING THE SUSTAINABILITY OF REEF FISHES FOR THE AQUARIUM TRADE IN SELECT SITES IN THE PHILIPPINES (Abstract ID: 29132)

Aquarium trade heavily relies on coral reef resources. In the Philippines, a top exporter of aquarium fish, the sustainability of this trade is a concern due to its capture methods and unreliable trade figures, as well as the lack of clear management policies and regulations. This study determined the status and sustainability of target reef fishes for the aquarium trade by comparing the level of exploitation and standing stock in four sites, namely, Lian, Batangas; Bongao, Tawi-Tawi; Cawayan, Masbate; and Kawayan, Biliran. Underwater fish visual census (FVC) was conducted to estimate densities of target fishes on the reefs while fisheries surveys using semi-structured interviews and focus group discussions were used to obtain information on the aquarium trade. Results show that target aquarium species varied across municipalities, majority of which belonged to the families Pomacentridae, Labridae, Pomacanthidae and Chaetodontidae. These families generally had low densities on the reefs, implying that fishes marketed for the aquarium trade are being sourced from areas outside the municipality. In fact, average weekly demand during peak season is significantly higher than actual densities observed on the reefs. High catch rates influenced by the demand from the aquarium trade may make this reef-dependent livelihood unsustainable in the long term. Continuous monitoring, as well as other studies (e.g. population biology of targeted species), are needed to formulate urgent regulations on the aquarium trade if these reef fishes were to persist.

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DEVELOPMENT OF MICROSATELLITE PROTOCOLS FOR CORAL MADRACIS COMPLEX (Abstract ID: 28327 | Poster ID: 337)

After the declaration of the Colombian Marine Protected Area-MPA Deep Coral Natural National Park (PNNCP) in 2013, it became evident the need to develop a management plan for this MPA in the Colombian Caribbean. One of the interesting features of this MPA is that the main structural species belong to the coral complex Madracis sp (Pocilloporidae: Cnidarian) in the area: M. auretenra, M. myriaster and M. brueggemanni. This group brings a special habitat to many species of fishes and marine invertebrates in mesophotic and deep reefs within the PNNCP. However, there is little information about this ecosystem, distribution, genetic diversity and connectivity in Colombia and the Caribbean. Here we present the main results from the development of new molecular markers (microsatellites) for some Madracis species, following methods previously developed at The University of Manchester for the deep coral Lophelia pertusa. DNA extractions were carried out at the Colombian Institute of Marine and Costal Research – INVEMAR, using samples from the Cnidarian reference collection at the Marine Natural History Museum of Colombia-MHNMC (INVEMAR), collected from Tayrona Natural National Park and PNNCP. DNA extractions were also developed at The University of Manchester from Madracis corals maintained in aquariums. The new markers will allow us further ecological analysis to increase the knowledge of these Caribbean coral formations and will help us to determinate the vulnerability and resilience of these habitats to natural and anthropogenic effects this new Natural National Park.

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IMPORTANCE OF SYMBIONT GENETIC STRUCTURE IN RESTORATION OF CORAL POPULATIONS (Abstract ID: 28916)

The short- and long-term success of any restoration project involving corals may depend on choosing the appropriate genetic source to be compatible with the site under restoration. Species vary in their dispersal rates and distances, and hence in the degree of genetic differentiation among populations. *Acropora palmata*, as do many species of corals, forms a symbiotic relationship with single-celled dinoflagellates of the

genus*Symbiodinium*. The symbiont provides the coral its main source of carbon compounds; however, the two organisms have different life history traits that can influence their geographic distribution. We estimated the population genetic structure of *Acropora palmata* and its dominant symbiont *Symbiodinium 'fitti'* along the Caribbean coast of Mexico, using previously designed microsatellite loci for *A. palmata* and *S. 'fitti'*, as a tool to assess genetic variation of source populations. In the animal host, we detected a single genetic cluster among 7 reefs as a result of high levels of gene flow. However, the endosymbiont showed a genetically structured population under isolation by distance with 5 clusters detected. These results suggest that sexual recruits should be introduced at an early stage so that they will take up the locally available symbionts. Furthermore, these results imply that care must be taken in choosing destination reefs for restoration efforts involving fragments or late-stage recruits so as not to alter gene flow patterns among the symbiont populations.
http://www.icmyl.unam.mx/arrecifes/-banaszak.html

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INTERSPECIFIC BACTERIAL COMPETETION UNDER OCEAN ACIDIFICATION SCENERIOS (Abstract ID: 29510 | Poster ID: 143)

Coral microbes have been hypothesized to promote coral health and protect the host against pathogens. Recent outbreaks of coral diseases have been correlated with higher sea-surface temperatures and ocean acidification but few studies focus on the effect of these stresses on coral commensals physiology. This study examined the impact of ocean acidification on two coral commensals' ability to prevent infection by the coral pathogen Vibrio shiloi. Beneficial bacteria Pseudoalteromonas ZJ6102 and Pseudoalteromonas euthinica were isolated from the surface of healthy Acropora cervicornis and, when challenged with V. shiloi, resulted in an antibacterial response. Competition experiments were performed by mixing equal amounts of each commensal with the pathogen in dialysis tubing maintained at high (pH=8.1) or low (pH=7.7) pH under stable temperatures (25.5°C). Colony forming units (CFUs) of each strain were calculated 24, 48 and 72 hours after inoculation. Results showed that lower pH tends to boost commensals ability to limit the pathogens growth. To test commensals ability to protect the host from bacterial infection, inoculation experiments were performed with A. cervicornis. Coral health was estimated visually and indirectly using a PAM underwater fluorometer to assess algae deterioration by the pathogen. Results showed higher photosynthetic activity for corals treated with both the pathogen and commensal compared to controls treated with the pathogen only. Studies such as these will help our understanding of coral microbial dynamics in response to environmental changes.

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BRAZILIAN MPAS EFFECTIVENESS: A CASE STUDY IN SÃO PAULO (Abstract ID: 29386 | Poster ID: 641)

The establishment of marine protected areas (MPAs) in Brazil is still negligible, just over 31% of the target set by the National Biodiversity Commission to protect 10% of the coastal zone by 2020. Most of them are terrestrial area and only 1.57% of the 3.5 million square kilometers of territorial sea is represented. The coast of São Paulo State (SP) has 700 km long and a great diversity of ecosystems, which are increasingly threatened due to its strategic location in relation to major industrial centers of the country, the connection to port systems and the exploration of oil in the pre-salt Santos Basin. Only 0.7% of the territorial sea is included in three restrictive MPAs. However, before to create new MPAs it's necessary to evaluate the effectiveness of existing ones. In this sense, present study aimed to analyze the management conditions "no take" MPAs of SP. The areas were evaluated through a selection of indicators, which were organized into scenarios matrix and associated with a standard score corresponding to the best or worst possible situation to be found. The management scores attained effectiveness of 68% (Tupiniquins Ecological Station), 71% (Tupinambás Ecological Station) and 72% (Laje de Santos Marine State Park). The main common factors that compromise the complete fulfillment of the objectives of the studied areas are the lack of an integrated coastal management with other economic sectors and low government resources allocated. However, they are surrounded by sustainable use areas, which ensure certain integration of MPAs with an ecosystem approach.

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FORAMINIFERAL HEALTH ASSESSMENT INDICES AND SEDIMENT GEOCHEMISTRY OF CORAL REEF-SUPPORTING TAMANDARE BAY (NE, BRAZIL). (Abstract ID: 29130 | Poster ID: 287)

This study aimed to assess spatial and temporal ecosystem health variability of water and sediment in the coral reefs of the Tamandare open embayment, located in Northeast Brazil, Southwest Atlantic Ocean, using geochemistry and benthic foraminifera as bioindicators. Sediment samples were collected at the reef base, generally built over beachrock structures, during the summer and winter of 2005. The FORAM index (FI, a foraminiferal functional group, community-based water quality assessment), and the FORAM Stress Index (FSI, which is more related to ecological affinities than to functional groups and assesses sediment or substrata quality) and geochemical data were interpreted using uni- and multi-variate analysis. This is the first application of FSI outside of Mediterranean waters. The dominance of the Quinqueloculina and Textularia genera, along with negligible numbers of living specimens, low counts of symbiont-bearing foraminifera (and thus low FI), high turbidity and high phosphorus concentrations confirm the anthropogenic influence of river inputs. All parameters suggest that the water and sediment of the Tamandare embayment are marginal for coral population settlement, and the FSI presents higher values and a more sustainable condition for summer than winter. The FI indication of marginal environmental health is not in agreement with the FSI and the currently stable coral population found over the underlying beachrock, especially of the established no-take zone. Local scientific- and community-based coral conservation initiatives have improved ecosystem health.
http://www.geoquimica-uff.org/#!docentes/c8hd

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CHARACTERIZATION OF RECREATIONAL SPEARFISHING IN A SUBTROPICAL ROCKY REEF (Abstract ID: 29980)

Spearfishing is a highly selective activity, but the selectivity does not necessarily make it a sustainable one, as the majority of defenders of this fishing method claim. This study aimed to evaluate which traits make fished species more or less attractive to spearfishers and the relationship between fishermen expertise and characteristics of the catch in rocky reefs in the Southeastern Atlantic. The investigation was carried out in the Marine Extractive Reserve of Arraial do Cabo (23oS; 42oW). In terms of abundance, scarids was caught by most, and captured fish biomass was mainly composed of herbivores and macro-carnivorous fish. The main attributes that make a species a preferential target were, firstly, pelagic habitat, larger size and a tendency to form schools. Our study had also shown a direct relation between the fishers's experience and catch composition, where experienced spearfishers catch mainly fish with larger sizes and weight. Old spearfishers recognize that stocks of targeted fish have reduced throughout time, and clear indication that environmental reference is changing, a phenomenon global reported. Spearfishing generally means a selective fishing, but it is high dependent on fishermen. To minimize the effects of spearfishing on target species and to enhance protection of functionally important fishes, spearfishing needs restrict controls on the catch.
http://www.lecar.uff.br/team_p_9.html

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GOVERNANCE ANALYSIS USING THE FISH CHAIN METHODOLOGY: PNG'S BÉCHE DE MER INDUSTRY (Abstract ID: 28079)

Markets for Béche de Mer (BDM, dried sea cucumber) are vital to coastal communities in Papua New Guinea (PNG). Many of these communities are remote from trade routes and have extremely limited economic opportunities. Dried BDM is high value and shelf stable, making it one of the few commercially feasible exports from such locations. Moreover, some of the most valuable species of BDM are easily accessible from shore, meaning the fishery has been open to people without access to boats, such as women, children and old people, and so the income from BDM has been distributed relatively equitably. As ethnic Chinese markets for BDM grew over recent decades PNG's remote coastal communities came to rely heavily on this resource for cash incomes. The management system was, however, not effective and stocks collapsed. In 2009 the PNG government closed the fishery. Surveys conducted in 2015 indicate some recovery and the government is considering reopening the fishery in the near future, with a revised management plan. This project uses a 'fish chain' methodology to consider all of the various influences along the supply chain affecting governance of the fishery, including village-level cultural and economic contexts, business models for exporters and importers, and capacity issues for relevant government agencies. Findings and methods developed in this study are relevant for understanding why fisheries operate the way they do, where practice changes may be effectively encouraged or enforced, and by whom, as well as areas that are more resistant to change.

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GENOMICS OF LOCAL ADAPTATION IN POPULATIONS OF ACROPORA MILLEPORA FROM THE GREAT BARRIER REEF (Abstract ID: 29490)

Local adaptation of coral populations inhabiting disparate reef environments could be the major source of genetic diversity to fuel rapid adaptation to climate change. To investigate this possibility, we performed genome scans using 2bRAD in populations of Acropora millepora from six locations along the Great Barrier Reef representing a variety of thermal and water quality conditions. We then undertook common garden and reciprocal transplantation experiments to see whether variation at the candidate loci identified by the genome scan were associated with fitness and/or gene expression variation among locations. The clearest genome scan signal, combining both high genetic divergence and elevated linkage disequilibrium, was obtained for two adjacent single-nucleotide polymorphisms (SNPs) located within a cluster of paralogous genes encoding delta-9 desaturases (d9d), enzymes that adjust the fluidity of biological membranes in response to ambient temperature. These SNPs formed a latitudinal gradient of allele frequency and were associated with elevated baseline expression of two d9d genes at a cooler, higher latitude, location. These genes also exhibited gene expression plasticity aligned with this baseline change: they were up-regulated in corals that were transplanted from a warmer to a cooler location. Thus, evolution of elevated baseline expression of these genes at a cooler location may represent a case of genetic assimilation, whereby regulatory adaptation is based on a pre-existing plastic response.

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SPATIAL AND TEMPORAL SETTLEMENT PATTERNS OF SCLERACTINIAN AND BLUE CORALS IN NORTHWESTERN PHILIPPINES (Abstract ID: 29523)

The Philippines is part of the coral triangle area with the highest coral biodiversity. Coral recruitment is important in structuring reefs by coral replenishment and recovery from degradation. In this study, spatial and temporal settlement patterns of scleractinian and blue corals in the northwestern Philippines were quarterly monitored for 3 years (2006 to 2009) in four study sites (i.e. Balingasay, Malilnep, Cory Sand Bar and Caniogan) by deployment and retrieval of settlement plates every 3 months. Results showed that the settlement patterns significantly differ among years, monitoring periods, and sites. Settlement patterns decreased from year 1 to year 3 and peaked between February to May. Settlement pattern of scleractinian and blue corals coincide with the peak of spawning season observed in the study sites. Among sites, Caniogan had the highest settlement which is mostly composed of Pocilloporidae (brooders) and Others (unidentified corals). Blue corals that are also brooders were only observed at Balingasay and Malilnep probably explained by the presence of adult corals only on these sites. Results suggest that high proportion of brooders (i.e. Pocilloporidae and blue corals) may have contributed to self-recruitment on the reef. High settlement in Caniogan can be attributed to its location that is relatively embayed among sites. Therefore, coral settlement is affected by the presence of adult colonies, timing and modes of reproduction and site attributes such as exposure to wave actions.

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ASSESSING CORAL REEF RESILIENCE TO OCEAN ACIDIFICATION IN THE PALAU ARCHIPELAGO (Abstract ID: 29545)

Climate change-driven shifts in ocean chemistry are projected to significantly affect the structure and function of coral reef ecosystems. Reef scientists and managers are increasingly assessing the resilience of coral reef ecosystems to climate change, yet most do not consider the effects of ocean acidification. For the first time, we present a reef resilience assessment that includes coral community tolerance to ocean acidification in Palau. Using five years of water sampling data, we mapped spatial and temporal patterns in temperature, salinity, and carbonate chemistry for the entire Palau archipelago and combined information about Palau's coastal environment with benthic community ecology and coral biology data. Archipelago-scale coupled physicochemical, ecological, and biological data allow us to map relationships between patterns in pH and coral community structure, reveal coral reef sensitivities to natural gradients in carbonate chemistry, and identify areas of potentially high resilience to ocean acidification impacts. Our results will be used to support coral reef conservation efforts in the region, specifically, identifying conservation priorities in Palau. The effective management of coral reef ecosystems in Palau is critical to support social and ecological resilience.

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IDENTIFYING COST EFFECTIVE ACTIONS TO MITIGATE LAND-BASED SOURCES OF POLLUTION IN WEST MAUI THROUGH DECISION MODELS (Abstract ID: 28555)

Coral reefs are declining across the world. Causes of coral reef decline are complex, and establishing direct causal links between deleterious inputs, events, or actions, and these declines, is challenging. However, it is clear that a cocktail of land-based sources of pollution presents serious threats to coral reef ecosystems, and addressing these has become a key management challenge worldwide. In the face of high levels of uncertainty in both action feasibility and future change, decision models can facilitate improved outcomes over the long term. We applied a decision science approach to address land based pollution within a watershed planning initiative, with the objective of identifying a suite of feasible actions and policy measures that will ensure healthy coral reefs that support livelihoods over long time horizons. In West Maui, Hawai`i, nearly one quarter of all living corals have been lost in the thirteen years prior to 2008. The Watershed Planning process includes the values and objectives of local stakeholders and decision makers, and aims to quantify and explicitly address uncertainty in parameter estimates and causal relationships, and the risks, or consequences, of delayed action or failure of a given action. We present the first phase of this work.

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INEQUITY IN CO-MANAGEMENT OF CORAL REEFS (Abstract ID: 28240)

Co-management has been promoted as a more equitable form of coral reef management because it provides local communities with greater power over the use and allocation of their resources. Yet co-management arrangements can exacerbate existing inequalities across regions and communities, and the benefits associated with co-management are not always equitably distributed. Here, we surveyed 790 resource users in 43 coral reef co-management arrangements across five countries to examine the benefits that resource users report from co-management, identifying departures (either losses or gains) from those of the wider community as inequity. We then evaluate how social and institutional factors contribute to actual and perceived inequity in benefits from co-management. We find that inequity is driven by contextual conditions (e.g., distance to market and population), institutional design (graduated sanctions, clear boundaries, and the rules in use), and individual socioeconomic conditions (wealth and involvement in decision-making). Managers and policy-makers can use some of these conditions, particularly institutional designs and individual socioeconomic characteristics, to inform the development of more equitable collaborative arrangements to manage and sustain coral reefs.

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SOLUBLE ADENYLYL CYCLASE IS AN EVOLUTIONARILY CONSERVED PH SENSOR IN THE CORAL POCILLOPORA DAMICRONIS (Abstract ID: 29984)

Reef-building corals experience daily fluctuations in intracellular pH (pHi) due to photosynthesis by intracellular symbiotic algae of the genus Symbiodinium, yet little is know about the cellular mechanisms used by corals to detect and regulate acid/base homeostasis. Here we found that the enzyme soluble adenylyl cyclase (sAC) is essential for sensing and regulating pHi in the coral Pocillopora damicornis. Expression of sAC was detected throughout all coral tissues, including gastrodermal cells that house the Symbiodinium, and calicoblastic cells that support calcification. Application of the sAC-specific inhibitor KH7 to isolated coral cells resulted in significant and reversible intracellular acidosis in both Symbiodinium-containing and Symbiodinium-free coral cells. Furthermore, inhibition of sAC in cells exposed to light impaired pHi regulation in Symbiodinium-containing gastrodermal cells, indicating a role in sensing photosynthesis-induced pHi disturbances. Finally, sAC inhibition prevented the recovery of pHi following intracellular acidification during exposure to acidified sweater, indicating that coral sAC is also a sensor and regulator of pH disturbances from external origin. The presence of sAC in all coral cell types, together with its responsiveness to physiological pH changes, makes it an excellent candidate to sense acid/base disturbances and initiate multiple homeostatic responses. These mechanistic studies are particularly important for understanding the capacity of corals to withstand and adapt to environmental stressors such as ocean acidification.

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HUMAN DIMENSIONS OF REEF MANAGEMENT PLANNING: CRITICAL ISSUES ARTICULATED BY INDIGENOUS PRACTITIONERS FROM MICRONESIAN OUTER ISLANDS: YAP STATE (Abstract ID: 29861)

Coral reefs around the world are suffering from multiple stressors, and human communities relying on reefs and associated resources are trying to manage those resources in the face of accelerating ecological change. Simultaneously, human communities and their social structures are changing, and indigenous knowledge is being eroded due to multiple factors. The One People One Reef project works collaboratively with outer island communities in Micronesia to identify traditional knowledge and management practices, provide scientific data to local practitioners, and to identify their primary concerns and issues around reef protection and management. Identification of issues surrounding reef management is the first step to better understanding how to approach ecological questions too. In 2014, we convened a Yap outer island workshop with representatives from 17 outer islands and Atolls to identify primary concerns, traditional methods still in practice, and collective recommendations. A modified grounded theory approach was used to identify patterns and key points. This presentation will outline the main findings from that workshop, with a focus on traditional management, changes in management, and identification of main areas of concern for outer island communities with respect to improved management of reefs and resources.
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VERY LOCAL ADAPTATION IN CORAL THERMAL TOLERANCE LIMITS: EVIDENCE FROM 2.5 COUNTRIES, 2 OCEANS, AND 2 SPECIES (Abstract ID: 29704)

It is well known that the same species of coral from different latitudes can differ in bleaching thresholds by as much as a few degrees. This has historically been attributed to an evolutionary tuning of coral thermal limits to the conditions of their local environment (i.e. local adaptation). Recently, a growing body of evidence is finding that corals from different micro-habitats within the same reef-system separated by only 500m to 5km can differ in bleaching tolerance by as much as or more than corals from contrasting latitudes 100s - 1000s of kilometers apart. Here, we present data comparing the response of corals from three study sites to experimental heat stress: a set of shallow back-reef pools in American Samoa, a nearshore and offshore patch reef in the Florida Keys, and a back reef and fore reef in Belize. In all three cases, corals from the microhabitats with the highest amount of daily variability in temperature showed the greatest resistance to bleaching compared to conspecifics from sites with more stable temperatures. These differences were consistent despite long periods of common garden acclimation (30, 36, and 240 days for Belizean, Samoan, and Floridian corals respectively), and similar symbiont types. As a whole, these results combined with those of other recent studies suggest that the amount of thermal variability may play an important role in shaping coral bleaching thresholds and that local adaptation may be as common at within-reef scales as it is thought to be across latitudinal gradients in ocean temperatures.

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TRANSLOCATION OF CORAL POPULATIONS TO ENHANCE THERMAL TOLERANCE: PERSPECTIVES UNDER THE ENDANGERED SPECIES ACT (Abstract ID: 29828)

Reef-building corals face a precarious situation of continued decline, and the recent expansion of coral species listings under the Endangered Species Act (ESA) reflects increased governmental concern and elevated conservation potential. Intra-regional translocation—informed by in situ and satellite data on current temperature regimes and model forecasts of future warming—of coral colonies predisposed to higher ambient temperatures may stave off regional coral species extinctions or the loss of reef ecosystem function by redistributing genetic thermal tolerance traits of symbionts and/or coral hosts. Although active translocation efforts are associated with inherent biological risks of vectoring invasive species and disturbing local genetic makeup, these risks can be mitigated through regulating procedures and the limiting of geographic translocation distance. Other examples of translocations of ESA-listed vertebrate and plant species illustrate the propensity for conservation efforts to reflect elevated risks when the species conservation status worsens. Using textual analysis of the ESA and case precedent, the appropriate risk thresholds are identified to ensure the continued survival of listed coral species. Under the ESA there may be a higher impetus to translocate listed coral species as opposed to non-listed species, indicating regional and management priorities. Case studies within U.S. jurisdiction are identified for potential translocation programs of listed coral species.

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THE IMPORTANCE OF STRESSOR INTERACTIONS ON MACROALGAE IN URBAN ENVIRONMENTS WITH COMPLEX REGIMES OF MULTIPLE DISTURBANCES (Abstract ID: 28596)

Globally, ecosystems increasingly experience disturbance regime encompassing multiple stressors, where natural fluxes are amplified by human activities. In the urbanised, eutrophic environment of Singapore, bivariate smoothed models (GAMs) demonstrated that temperature and phosphate operate interactively, resulting in seasonal modulation of nutrient impacts on reef macroalgae. Although algae seasonal patterns were maintained, there was a noticeable reduction of persistent, opportunistic algae groups and reorganisation of dominant groups. Source of acute and chronic stresses in the system were identified and a generality in the patterns of the response of algae functional groups to these stressors was found. Both synergistic and antagonistic interactive effects were observed in species responses to the variation in the physico-chemical regime. Antagonistic interactions can mitigate deleterious effects of single stressors, conversely synergistic interactions can exacerbate single stressor effects in a non-additive manner. Understanding how these interactions operate enables a departure from the dogmatic categorisation of environmental parameters. This allows for better decision making, prioritisation in the development of ecological thresholds and setting of trigger values for management intervention.

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WATER QUALITY LINKED TO ABUNDANCE AND PHYSIOLOGY OF DOMINANT SOFT CORALS IN JAKARTA BAY, INDONESIA (Abstract ID: 28311)

Declining water quality is a main reason for coral reef degradation in the Thousand Islands off the megacity Jakarta, Indonesia. Shifts in benthic community composition to higher soft coral abundances have been reported for many degraded reefs throughout the Indo-Pacific. However, it is not clear to what extent soft coral abundance and physiology are influenced by water quality. In this study, benthic community composition and water quality (i.e. dissolved inorganic nutrients (DIN), turbidity, and sedimentation) were assessed at three sites (<20km north of Jakarta) in Jakarta Bay (JB) and five sites along the outer Thousand Islands (20–60km north of Jakarta), along with measurements of photosynthetic yield and respiratory electron transport system (ETS) activity of two dominant soft corals, Sarcophyton sp. and Nephthea sp. Findings revealed highly eutrophic water conditions in JB compared to the outer Thousand Islands, with 44% higher DIN load (7.65µM/L), 67% higher turbidity (1.49 NTU) and 47% higher sedimentation rate (30.4g m-2 d-1). Soft corals dominated within the bay (2.4% hard and 12.8% soft coral cover) compared to the outer Thousand Islands (28.3% hard and 6.9% soft coral cover). Soft coral abundances, photosynthetic yield, and ETS activity were highly correlated with key water quality parameters, particularly DIN and sedimentation rates. The findings suggest water quality controls abundance and physiology of dominant soft corals in JB and may thus contribute to phase shifts from hard to soft coral dominance, highlighting the need to better manage water quality.

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IMPACTS OF THE 2015-2016 EL NIÑO ON KIRITIMATI, THE WORLD'S LARGEST ATOLL (Abstract ID: 30125)

The 2015-2016 El Niño, which triggered the third ever global coral bleaching event, provided an extraordinary opportunity to rigorously examine the factors that govern reef resilience to thermal stressors. Such knowledge is crucial for developing targeted coral reef conservation strategies under climate change. Located in the central equatorial Pacific, Kiritimati (Christmas) atoll was at the epicenter of this El Niño event; the atoll was on Bleaching Alert 2 for many months. As the world's largest atoll by land mass, Kiritimati also has an unparalleled gradient of coral reef conditions: human impacts are concentrated at the NW corner of the atoll and reefs there are highly degraded, while at the other end of the atoll, the coral reefs are amongst the world's most pristine. Together, these attributes make Kiritimati an ideal location to learn about which corals can survive extreme heat stress events, which properties underlie coral reef resilience, and if bleaching impacts are minimized in areas with fewer local stressors. Here, we present new results from studies at twenty of our long-term monitoring sites across Kiritimati's

local disturbance gradient, which were conducted during six field expeditions carried out before (n=3) and during (n=3) the 2015-2016 El Niño event. We will synthesize the evidence of El Niño impacts on Kiritimati from our field data, which includes data from 500 corals tagged and tracked throughout the event, detailed photo data, in situ temperature and water quality instruments, and fisheries data.
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MACROALGAL BROWSING ON A HEAVILY DEGRADED, URBANIZED EQUATORIAL CORAL REEF SYSTEM (Abstract ID: 29319)

The removal of macroalgal biomass is a key process in maintaining a healthy balance between corals and algae on tropical reefs. Numerous studies have quantified rates of macroalgal herbivory using bioassays, however most have been conducted in areas with relatively low macroalgae cover (<5%) and abundant and diverse herbivorous fish populations. This raises the question of whether these studies are representative of degraded coral reef systems where coral cover, and the biomass of herbivorous fishes are markedly lower, and algal biomass substantially higher. Here, we surveyed herbivorous fish communities and quantified their capacity to remove the fleshy macroalga Sargassum ilicifolium using bioassays on multiple reefs in Singapore; a highly degraded urbanized coral reef system exposed to chronic disturbances. Removal of S. ilicifolium biomass varied significantly among reefs (1.2–73.4% 4.5 h-1), but spatial variation was consistent between days, suggesting the strong localized effects of environment and behavior in the component species. Interestingly, despite strong spatial differences video footage revealed that a single species, Siganus virgatus, was almost solely responsible for the removal of algal biomass. Of the 5,302 bites taken from assays across all sites, S. virgatus accounted for 82.1% (4,353) of the total bites. These findings not only highlight the limited redundancy within this system, but importantly that substantial macroalgal removal occurs on these reefs and that there is a need to assess the functional roles of individual species even on degraded reefs.

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INFLUENCE OF THERMAL HISTORY AND NUTRIENT ENRICHMENT ON CORAL AND SYMBIONT COMMUNITY STRUCTURE ON LAGOONAL REEFS ON THE BELIZE MESOAMERICAN BARRIER REEF (Abstract ID: 28070)

Coral reefs are increasingly threatened by rising seawater temperature and human-induced nutrient enrichment. Unclear is how spatiotemporal variations of these environmental stressors across a reefscape determine which coral species will be most successful during this climate change interval. Using a novel metric, we classified lagoonal reefs on the Belize Mesoamerican Barrier Reef as enduring low, moderate, or extreme temperature parameters (lowTP, modTP, and extTP, respectively) over the past decade using satellite-derived ultra-high resolution sea surface temperature records. Bulk nutrient concentrations were determined for each site from satellite-derived chl a proxy complemented with in-situ nutrient measurements. Reefs classified into one of the three thermal parameters were surveyed and coral tissue samples were collected to classify the symbiont community. Coral abundance, diversity, percent cover, and species richness were significantly lower at extTP sites compared to lowTP and modTP sites, which did not differ from each other. Coral community differences between extTP and lowTP/modTP sites were primarily driven by temperature differences. The influence of nutrients on coral communities was minimal. Metabarcoding of the ITS2 gene will reveal how Symbiodinium communities vary across host species and between reef environments and will elucidate how temperature and nutrients drive patterns in holobiont communities. Coral communities at extTP sites warrant additional protected status, as they may be better adapted to withstand future ocean conditions.

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MICRO-RNA MEDIATED HOST TRANSCRIPTOME MODULATION IN THE CNIDARIAN-DINOFLAGELLATE ENDOSYMBIOSIS OF AIPTASIA (Abstract ID: 27840)

The functional endosymbiosis of a cnidarian coral host and photosynthetic dinoflagellate algae of the genus Symbiodinium forms the trophic and structural basis of coral-reef ecosystems. The acquisition of Symbiodinium from the environment during larval development or during the recovery from stress-induced symbiosis breakdown ("bleaching") is generally accompanied by specific alterations in host gene expression. However, the precise regulatory mechanisms modulating the cnidarian host transcriptome are not known. Here we present evidence for post-transcriptional gene regulation by miRNAs in the small sea anemone Aiptasia, a model system for cnidarian-dinoflagellate endosymbiosis. We find that Aiptasia encodes mainly species-specific miRNAs and provide evidence for recent differentiation of miRNAs within the Aiptasia genome that are commonly conserved among anthozoans. Our analysis of miRNA expression shows that both conserved and species-specific host miRNAs are differentially expressed in response to endosymbiont infection and maintenance of the algal endosymbiosis. Using cross-linking immunoprecipitations (CLIP) of Argonaute, the central protein of the miRNA-induced silencing complex, we identified miRNA binding sites on a transcriptome wide scale and find that symbiotically regulated miRNAs are modulating genes involved in Symbiodinium infection. Taken together, our findings provide evidence for an effective role of miRNAs in modulating the host transcriptome during the onset and maintenance of the cnidarian-dinoflagellate endosymbiosis.
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GENETIC DATA INDICATES THAT HYBRIDIZATION BETWEEN CARIBBEAN ELKHORN AND STAGHORN CORALS IS A LIKELY MECHANISM FOR RAPID ADAPTATION (Abstract ID: 28347)

Current models predict the demise of reefs in the next 200 years. It is thus essential to identify habitats, taxa and evolutionary mechanisms that will allow some coral species to maintain their role as foundation fauna. Hybridization can provide an avenue for adaptation to changing conditions and corals hybridize with some frequency. But results may range from the introduction of just a few alleles into existing parent species via introgression, to the birth of a new, perhaps better adapted genetic lineage. Here, we concentrate on once dominant but now threatened species, Acropora cervicornis and A. palmata. In the past, hybrid colonies originating from natural crosses between elkhorn and staghorn corals were rare, and only infrequent hybrid reproduction with staghorn coral was evident, limiting the evolutionary potential of this hybrid system. New genetic and genomic data indicate that hybrids are now mating with each other, demonstrating the potential for the formation of a new species. Further, hybrids appear to be capable of mating with both staghorn and elkhorn coral, perhaps leading to gene flow between the parent species via the hybrid. Recent field observations suggest that the hybrid is increasing and its ecological role is changing throughout the Caribbean. These hybrids appear to be less affected by the disease that led to the mass mortality of their parental species in recent decades. Hybrids are also found thriving in shallow habitats with high temperatures and irradiance suggesting they may be less susceptible to future warming scenarios. Hybridization is thus a possible and probable mechanism for coral adaptation to changing conditions in the Caribbean.
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GENOMIC SIGNATURES OF HABITAT ADAPTATION ARE MIRRORED BY PHENOTYPIC DIFFERENCES IN THE CORAL *POCILLOPORA DAMICORNIS* (Abstract ID: 28959)

The future of coral reefs is uncertain. Increasing environmental pressures are causing stress and decreases in coral fitness, cover and diversity are evident on reefs world-wide. The outlook depends on corals' ability to increase stress tolerance and thrive under novel, and often more extreme, environmental conditions. To provide critical knowledge of the adaptive potential of natural populations we reciprocally transplanted fragments of*Pocillopora damicornis* between environmentally distinct reef flat and slope habitats (separated by < 100 m) at two sites ca. 1 km apart at Heron Island, GBR. We detected

strong genotype by environment interactions in fitness-related traits; skeletal growth was 3.5 times higher and partial mortality was 3.2 times lower in native vs novel habitats. Field and lab experiments found higher stress tolerance in native corals from the more environmentally extreme reef flat habitat, with transplanted slope individuals achieving intermediate tolerance levels after 18 months. Analysis across 23,500 SNPs identified strong genetic differentiation between habitats and a large number of private alleles were associated with habitats but not sites. Our results are consistent with local adaptation of coral populations across very small geographical distances and reveal standing genetic variation for enhanced temperature tolerance in natural populations. Combined, our phenotypic and genomic data support a substantial adaptive potential of this coral species that should be considered in projection models under emission and natural management scenarios
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EVOLUTIONARY RESCUE AND GENOMIC ADAPTATION TO OCEAN WARMING (Abstract ID: 28245)

Persistence of coral populations through warming ocean temperatures will require adaptation to new climates. Although many studies have used genomic data to examine the potential genetic basis of this adaptation by searching for climate-associated variation, few have applied their findings to predict evolution under future climate change scenarios. Here, we examine the probability of adaptation in a low latitude population of reef-building corals from Rarotonga, Cook Islands. Using candidate single nucleotide polymorphisms (SNPs) associated with thermal tolerance from a previous study in the same species, we simulate population trajectories with selective regimes reflective of warming scenarios. We find substantial capacity for adaptation to warming in the Rarotonga population, but this estimate is highly dependent on both population growth rate and the rate of warming. In addition, we show that spatially heterogeneous habitats may increase the likelihood of evolutionary rescue through assortative mating of more fit genotypes. Merging empirical genomic data with evolutionary models offers a promising method for integrating adaptive processes into predictions of species response to climate change.

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RECENT BFAR INITIATIVES RELATING TO EAFM (Abstract ID: 29193 | Poster ID: 577)

This paper will present EAFM initiatives of the Bureau of Fisheries and Aquatic Resources(BFAR) as the primary agency responsible for the conservation and Management of Fisheries in the Philippines.It will include the various management plans/ programs/projects/measures for specific fisheries being implemented in various parts of the country, the recently formulated Comprehensive National Fisheries Industry Development Plan, and other related activities. The process of formulation and implementation of these plans/programs/projects/measures and how they relate to EAFM will be described.
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THE ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT (EAFM) FRAMEWORK IN THE CONTEXT OF FISHERIES MANAGEMENT IN THE PHILIPPINES (Abstract ID: 29333)

The Ecosystem Approach to Fisheries Management (EAFM) includes a wider scope of implementation than the fisheries management practiced in the last decades. While the conventional and traditional fisheries management mostly involved activities that focused only on the fisheries sector, the EAFM takes into consideration a broader and multi-sectoral participation; promotes good governance; and utilizes traditional and scientific knowledge to support appropriate adaptive management strategies. The Philippines is mainstreaming and integrating the EAFM concept into the management of various fisheries. In the Philippine context, several successful initiatives will be shared highlighting policy reform, institutional and structural reforms, infrastructure support, broad multi-sectoral collaboration, and promotion of the human well-being.
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PROJECTING RESPONSES IN STRESSED MARINE SYSTEMS (PRISMS): MEASURING AND PROJECTING MULTIPLE LOCAL THREATS AT A GLOBAL SCALE (Abstract ID: 28379 | Poster ID: 426)

PREDICTS (Projecting Responses of Ecological Diversity In Changing Terrestrial Systems) is an ongoing collaborative project which uses a meta-analytic approach to investigate how local biodiversity typically responds to human pressures such as land-use change and infrastructure, thereby improving our ability to predict future biodiversity changes (e.g. Newbold et al. (2015) Nature 520: 45-50). The PREDICTS project has already been extremely successful at synthesising raw data from scientists worldwide in order to produce a global database of terrestrial species' responses to human pressures (now having over 3 million biodiversity records from over 27,000 sites, covering more than 47,000 species). We are now extending the methodology to shallow coastal benthic marine communities at a global scale within the 'PRISMS' project, looking at local ecological community change according to associated anthropogenic pressures (primarily land-use change). This is with the aim to compare local within-sample taxon richness, rarefaction-based taxon richness, total abundance, and compositional turnover across regional and global scales, along gradients of human pressure. The responses of reef site-level diversity to the measures of anthropogenic land-use change are modelled using generalized linear mixed effects models. Models will also be projected onto future scenarios of anthropogenic and environmental pressure variables to aid reef management.

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CORAL-ALGAL DYNAMICS UNDER FUTURE CARBON DIOXIDE SCENARIOS AND EUTROPHICATION (Abstract ID: 28306 | Poster ID: 112)

Coral reefs are threatened by the consequences of increasing atmospheric carbon dioxide (CO2) leading to seawater warming and acidification, and eutrophication from crop-fertilization. Many studies suggested that algae will dominate corals in the future; however, multiple stressors provoke complex responses and their combined impacts on corals, algae and their interactions are unknown. This research focused explicitly on the synergistic effects of seawater warming and acidification under presence and absence of eutrophication on the survival of key reef organisms and their interactions under simulated present and future CO2 scenarios. Winter experiments were carried out on Heron Island, Southern Great Barrier Reef, in which Acropora pulchra coral fragments and thalli of the tropical brown algae Chnoospora implexa, both alone and in interaction, were exposed to present and "business-as-usual" pCO2 and seawater temperature (RCP8.5; + 570 µatm pCO2 and + 4°C), and to ambient and elevated inorganic nutrients (2.5 µmol L-1 ammonium and 1.25 µmol L-1 phosphate). Performance and function of corals and algae were assessed by measuring growth, productivity, pigments, and tissue nutrient content. Preliminary results showed no negative interaction between algae attached to corals under any treatment. While algae had a significant mortality after experimental mid-term, coral fragments showed growth and an increase in pigmentation in treatments with elevated nutrients. The outcome of this study will provide robust experimental evidence of the fate of future coral reefs' integrity.

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NO-TAKE MARINE PROTECTED AREAS ALTER BENTHIC COMMUNITIES WITH CASCADING POSITIVE EFFECTS ON CORAL SETTLEMENT AND LARVAL AND RECRUIT SURVIVORSHIP (Abstract ID: 28020 | Poster ID: 629)

Macroalgae can harm corals via numerous mechanisms and coral larvae avoid cues from many species of macroalgae in settlement and flume experiments. However, coral larvae may not be able to avoid settlement near macroalgae with reefs globally becoming more degraded due to increasing anthropogenic stressors. We tested for the effect of substrates from a coral-dominated no-take marine protected area (MPA) compared to substrates from an adjacent fished reef dominated by macroalgae on larval settlement and recruit survivorship of the coral Pocillopora damicornis. We also tested for differences in survivorship of larvae from MPA and fished reefs when maintained in water collected from each reef. Larvae from both MPAs and fished areas initially (≤ 24 h)

avoided settlement on macroalgal-fouled substrate collected from the fished area, but no longer avoided settlement after 48 h. When out-planted to the protected or fished area, larvae from both areas experienced higher post-settlement survivorship at 4 and 26 days within the MPA than the fished area. Larvae from the fished area had lower survivorship than larvae from the MPA and this effect was exacerbated when larvae were maintained in water from the fished area compared to the MPA. These results indicate that no-take MPAs improve coral settlement and survivorship at multiple life stages. Protected areas may also select for healthier microbial communities. We are currently investigating microbial effects in the observed settlement and survivorship patterns between fished and protected reefs.

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WILL YOUR DATA BE USEFUL AFTER YOU ARE GONE? U.S. FEDERAL DATA MANAGEMENT POLICIES AS RECOMMENDATIONS FOR ALL SCIENTISTS (Abstract ID: 28748)

The Public Access to Research Results (PARR) policy is being implemented across all federal agencies in the United States. It requires all data collected with federal funds be made publicly available in a timely manner. As part of it's implementation plan, the National Oceanographic and Atmospheric Administration (NOAA) has put a series of directives into place to address issues of data management, including, but not limited to, access, documentation and data citation. The Coral Reef Conservation Program (CRCP) funds the majority of projects dealing with shallow water coral reefs across different NOAA offices. These projects collect a wide variety of data from satellite derived products to in water monitoring. This range of data types along with differing office requirements provides a unique set of data management challenges. I will present an overview of how we are currently managing data within CRCP and talk about how these management practices are good recommendations for all coral reef researchers. Some of these recommendations include tools that are available to the wider research community. Data science is increasingly an important tool for resource management; this requires coral data managers to evolve how they manage and share coral data. Open access to publications and data is becoming more often a requirement rather than a recommendation, and as rigorous as scientists can be on their collection methodology, they should be equally as rigorous on how they manage their data. It is only through proper management that data can be made useful into the future.

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BUILT CAPITAL AND PEOPLE PROTECTED BY CORAL REEFS GLOBALLY, NOW AND IN THE FUTURE (Abstract ID: 29593)

Climate change and coastal development are dramatically increasing risks to people and property and to losses of coastal habitats. Exposure to flooding is increasing from the combined influence of coastal storms, changes in sea levels, land subsidence, urban development, population growth and geomorphic change. The need to upgrade existing flood protection and to plan for future risks is becoming increasingly apparent, as are the costs. This is driving billions of dollars to reduce those risks, creating both threats and opportunities for ecosystems. Habitat loss will further expose communities and assets to flooding and erosion. However, there very limited estimates of the actual asset value and people directly protected by ecosystems worldwide. We combined ecological, engineering and economic approaches to estimate the benefit we get from coral reefs across the globe, by comparing the present situation with a loss of 1m in height of coral reefs globally and scenarios that account for a future of sea level rise and reef degradation. The results are revealing. For example, as compared to the flooding currently predicted for 100-year events, the loss of just 1 m in coral reef height globally would trigger added flooding of more than 16,000 km2 affecting an additional 8 million people and $US186 billion in built capital; a 92% increase in storm costs. Some of the hotspots that enjoy the greatest benefit from coral reef nowadays are in rank order from SE Asia and the Middle East. The countries that have their total built capital protected by coral reefs include many Small Island Developing States and some larger island nations (e.g., Belize, Grenada, Philippines).

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ISLANDS OF SEA: THE ROLE OF ISOLATION IN SPATIAL PATTERNS OF MARINE BIODIVERSITY (Abstract ID: 29530)

Phylogeographic studies in the Coral Triangle have shown that populations of coral reef organisms are more structured than previously assumed and that isolation at small spatial scales may play an important role in forming the observed spatial patterns of genetic diversity. Isolation can affect genetic diversity due to physical barriers, irrespective of environment, and/or due to different environmental regimes. A key issue is that environmental data is generally spatially structured at multiple scales and will change over time, thereby clouding the ultimate cause of divergence and differentiation. Here we use the clearly defined spatio-temporal context of marine lakes – islands of sea - to study how gene flow corresponds with environmental gradients. Marine lakes are landlocked water bodies that maintain a marine character with coral reef organisms through narrow submarine connections to the sea. By comparing marine lakes in Indonesia, with comparable ages and sizes, but varying degrees of connection to the open sea and differing environmental regimes, we aim to test the relative contribution of dispersal limitation due to barriers versus selective environments in the formation of marine biodiversity patterns. We will present preliminary data of our study on multiple marine lineages (sponges, mussels, jellyfish) across the marine lake model system based on population genomic techniques (RADSeq). Understanding how geneflow corresponds with environmental gradients will improve predictions on adaptive capacities of species under different climate change scenarios.

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CARBON AND NITROGEN FIXATION BY REEF ORGANISMS AND SUBSTRATES IN RESPONSE TO SEASONAL CHANGES (Abstract ID: 27985)

Tropical coral reefs are among the marine ecosystems with the highest C fixation rates, although they are surrounded by very oligotrophic waters. This reef paradox is not yet completely understood. However, it is evident that mechanisms must be in place allowing extraction of essential elements, particularly new nitrogen. Several key reef C-fixing primary producers (e.g. corals, macro and turf algae) and substrates (e.g. reef sands, dead corals and rocky surfaces), exhibit internal or external associations with N-fixing microbes like cyanobacteria. Such associations potentially facilitate primary production, but there are no studies that address the potential linkage between C and N fixation in coral reefs under the influence of potentially controlling environmental factors. This contribution will thus present data from a series of experiments conducted during all four seasons at a high-latitude reef location in the Northern Red Sea, thereby exhibiting strong seasonality in key water parameters. Findings revealed a widespread occurrence of N fixation by diazotrophs associated with all major groups of reef organisms and substrates and a cross-organism linkage between C and N fixation when inorganic nutrient availability in the water column was lowest. Extrapolation of our data also characterize coral reefs among the most active N-fixing marine ecosystems. This comprehensive dataset will help to gain new important insights in coral reef ecosystem functioning and resilience in a time of environmental change.

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NITROGEN ACQUISITION VIA DIAZOTROPHY IN COLD-WATER, TEMPERATE AND TROPICAL CORALS (Abstract ID: 29273)

Dinitrogen ($N_2$) fixation by specialized prokaryotes (diazotrophs) represents an important source of bioavailable nitrogen (N) in the world's ocean. Among marine ecosystems tropical coral reefs have been identified as hotspots of $N_2$ fixation that may facilitate their high productivity despite being surrounded by oligotrophic waters. Recently, cold-water

coral associated $N_2$ fixation has also been demonstrated suggesting that coral-diazotroph associations are ubiquitous over large spatial and latitudinal scales. Several studies shed light on the abundance and diversity of coral-associated diazotrophic communities or quantified the amount of $N_2$fixation, while direct evidence for the uptake and metabolic usage of $N_2$fixation products by the coral host is still lacking. Thus, this talk will present a series of $^{15}N_2$ tracer experiments following the net incorporation of freshly fixed $N_2$ into the different coral compartments (tissue, zooxanthellae, skeleton, mucus) and its subsequent release into the surrounding seawater as organic and inorganic N. In addition, the uptake of fixed $N_2$ was comparatively investigated between cold-water, temperate and tropical corals to assess the specific nutritional importance of coral-associated $N_2$fixation for corals thriving in very diverse environmental settings.

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LIFE BEGINS AT 40: TOWARDS RESILIENCE-BASED MANAGEMENT OF THE GREAT BARRIER REEF MARINE PARK. (Abstract ID: 29079)

The Great Barrier Reef Marine Park Authority turned 40 years old in 2015. Like middle aged humans, the future of Great Barrier Reef ecosystems is dependent upon actions that sustain health. Since 1975 the GBRMPA has been adaptively managing the Marine Park to protect the outstanding universal value of this global icon. Actions such as the original (1975) and revised (2004) zoning have minimised extractive activities and ongoing water quality improvement measures are addressing 150 years of coastal development. However, like reefs worldwide, legacy and current human and environmental pressures are challenging the capacity of GBR ecosystems to tolerate and recover from impacts. In the coming decades the increasing effects of climate change combined with existing pressures threaten to overwhelm the capacity of conventional management arrangements to protect the Reef. In response to these mounting pressures the GBRMPA is working to enhance resilience through the Reef 2050 long-term sustainability plan. The GBRMPA is partnering with Australian and international managers, researchers and non-governmental organisations to translate resilience science into practical future focused adaptive management strategies. This presentation outlines some of the ongoing strategic, tactical, stewardship, monitoring and evaluation actions that have been developed over the past decade to trial and enable resilience-based management of the world's largest coral reef system.
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MACRO-INVERTEBRATE COMMUNITIES ASSOCIATED WITH HALICLONA SP. AND SPHECIOSPONGIA VAGABUNDA (PHYLUM: PORIFERA) FROM MAURITIUS (Abstract ID: 27876 | Poster ID: 294)

The macrofaunal communities associated with two distinct sponge species (Haliclona sp. and Spheciospongia vagabunda) were assessed along the east and south west coasts of Mauritius. Sponge samples were collected at a depth range of 0.5 – 2 m, dissected and the associated macrofaunal communities were collected, sorted and identified to the lowest possible taxonomic level. Faunistic associations were determined through cluster analysis using the Bray-Curtis similarity (PRIMER 6). A total of 26 macroinvertebrate species belonging to six taxonomic groups were recorded. Polychaeta was the most dominant taxa in terms of the number of individuals (51% of the total individuals) and Crustacea constituted the highest number of species (13 species). The polychaete Haplosyllis djiboutiensis and the brittle star Ophiactis savignyi were the most abundant associated species recorded. The numbers of individuals and the diversity index values were positively correlated the sponge volume. This study is among the first records on sponge-associated macrofauna in Mauritius and supports the importance of marine sponges as habitats for macro-invertebrates.

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INVESTIGATING CORAL REEF GRAZING AS A NATURAL CONTROL OF INCREASED ALGAL GROWTH IN TWO HAWAI'I NATIONAL PARKS (Abstract ID: 30047)

Recent studies in Hawai'i have shown that increased coastal nutrient inputs can accelerate nuisance algal growth in coral reef ecosystems. However, in areas with sufficient grazer density, excessive algal growth may be controlled. Our study investigated the top-down effects of grazing and the bottom-up effects of benthic nutrient inputs (through submarine groundwater discharge) on algal turf growth within two Hawai'i parks (Kaloko-Honokōhau NHP and Kalaupapa NHP). Increased algal growth was significantly correlated with greater benthic nutrient concentrations at both parks. Different grazer assemblages were studied within each park with visual and video sampling, and macroalgal grazing assays reflected differences in grazer effects on algal biomass at each park. In 2013-14, algal turf grazing experiments with controlled/excluded herbivory treatments were used to document significant grazer effects on algal turf biomass, with urchin-dominated grazing at Kaloko-Honokōhau and fish-dominated grazing at Kalaupapa. These findings provide valuable information on the role of herbivores in Hawaiian marine systems and similar regional environments, and emphasize the importance of management of herbivores in tropical marine systems.

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BENTHIC ALGAL GROWTH IN RESPONSE TO SUBMARINE GROUNDWATER DISCHARGE IN TWO HAWAI'I NATIONAL PARKS (Abstract ID: 30058)

Kaloko-Honokōhau and Kalaupapa National Historical Parks, experience sizable inputs of submarine groundwater discharge, which can supply large volumes of nutrient-laden freshwater from to coastal environments, potentially yielding nuisance algal growth. To investigate nearshore ecosystem responses to land-based inputs, known shoreline seeps and several randomly selected benthic stations were sampled in both parks during a four-year investigation. Nutrient concentrations were documented to be spatially and temporally variable. Generally, nutrient concentrations were not large from subtidal benthic stations compared to shoreline seep values. Results of macroalgae and algal turf growth experiments showed that algal growth varied greatly between parks and was associated with specific nutrient concentrations. Algal tissue analysis (N15) did not indicate sewage sources for available nutrients at selected benthic stations.

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OPERATIONALISING THE MANAGEMENT OF CORAL REEF RESILIENCE (Abstract ID: 29127)

Coral reefs are globally imperilled, with more frequent and severe disturbance events reinforcing the ecosystem's retrogression and impacting their ability to recover. The literature often highlights that managers should aim to conserve the most resilient reefs, i.e. those reefs that are least likely to experience phase shifts because their ecological and environmental conditions. Thus far, a hurdle to protecting resilient reefs has been that resilience plays out over long time-scales and is difficult to quantify in objective-based decision-making. Our paper aims to operationalize the management of coral reef resilience in quantitative terms and present a framework to maximise both mean resilience and cost effectiveness in reef management. By understanding their past responses to disturbances, we aim to predict the reefs' future resilience. Here, we estimate the mean long-term resilience of coral reefs on a global scale based on the understanding that resilience is governed by exposure rates to multiple disturbances, the sensitivity of reefs to a disturbance, and the rates of recovery. We estimate these components on a global scale based on long-term studies, and predict long-term reef trajectories with simple stochastic models. Our approach is based on factors of resilience that can be measured and managed, providing a framework for selecting management actions on the basis of local reef ecosystem trends and financial and logistical constraints of management.

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DEEP LEARNING IN THE SHALLOW SEAS: USING COLLABORATIVE PLATFORMS AND DEEP NEURAL NETWORKS TO GREATLY ADVANCE AUTOMATED ANALYSIS OF CORAL REEF SURVEY IMAGERY (Abstract ID: 28730)

Modern robotics and imaging technology enable rapid collection of large coral reef image surveys. However, the subsequent image-annotation required to extract data for ecological analysis is time-consuming and expensive, creating a manual annotation bottleneck between collected imagery and required data. We present an algorithmic framework and a collaborative platform to address this bottleneck.

The CoralNet (coralnet.ucsd.edu) image annotation platform has been freely available for 2 years. During this time, over 150,000 coral reef survey images have been uploaded as part of 288 different reef surveys, and annotated with over 4 million point annotations by 347 coral reef experts. Through the CoralNet interactive annotation tool, users already leverage automated image analysis to reduce the manual annotation work by 50%.

Using this wealth of data, we have developed the next generation automated annotation methods, using deep neural networks with 138 million parameters organized in 16 convolutional layers. Using these networks, we can further reduce the annotation burden so that, on average, only 20% of the annotation work remains for the human annotator. Remarkably, for surveys conducted with sufficient image quality, fully automated annotation is possible with *no reduction* of annotation quality compared manual annotation.

As more data is uploaded and verified, the CoralNet vision back-end will continue to evolve, creating a positive feedback loop to encourage further collaboration and enable rapid and accurate image based reef surveys.

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FILTERING OF CORAL REEF FISH HERBIVORY ALONG A GRADIENT OF WAVE EXPOSURE (Abstract ID: 28012)

Quantifying the heterogeneity of ecological processes is crucial to understand spatial patterns of ecosystem function. Here we quantify the spatial variability of coral reef fish herbivory and, using a trait-based approach we measure species swimming performance, and determine whether wave exposure acts as an environmental filter of herbivore feeding function. Species with distinct feeding strategies differed in swimming performance. Although high wave exposure impairs the feeding function of 22% of species, it doubles overall herbivore feeding intensity without affecting the percentages accounted for by grazers and scrapers. The likely antagonistic effect of wave exposure on fish feeding behaviour and algal productivity makes herbivory relatively resilient to the functional impairment of less manoeuvrable species. We argue that the significance of certain environmental filters may be overridden by those stemming from selective human activities. Extending our approach to further ecological processes and factors that may supress species functions, can help refine spatial predictions of ecosystem function, and assist conservation planning aimed at sustaining resilience to disturbance.

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RETENTION MECHANISMS AND SELF-RECRUITMENT IN A CORAL REEF FISH (Abstract ID: 28423)

The distance traveled and trajectories taken by marine larvae during dispersal are likely influenced by larval behaviors as well as oceanographic features. Passive retention mechanisms, such as eddies, are thought to enhance self-recruitment, that is, the return of larvae to their natal population. Exact locations of hatching and settlement of self-recruiting larvae enable tests of expected patterns of dispersal based on known patterns of water circulation. Using parentage inference based on multiple sampling years in Moorea, French Polynesia we describe spatial and temporal variation in self-recruitment of the coral reef orangefin anemonefish, evaluate the consistency of net dispersal distances of self-recruits against the null expectation of passive particle dispersal, and test the hypothesis that larvae originating in certain reef habitats (lagoons and passes) would be retained and thus more likely to self-recruit than those originating on the outer (fore) reef. Estimates of known self-recruitment were consistent across the sampling years (~ 25-27% of sampled recruits)..The vast majority (92%) of the larvae born on Moorea showed a net distance between hatching and settlement locations that was within the average maximum dispersal distance expected of a neutrally-buoyant passive particle. However, a parent of a given body size on the outer (fore) reef of Moorea was less likely than those on lagoon reefs or in passes to produce self-recruits. Our findings show that even simple dispersal models that simulate the spatial scale and direction of larval dispersal can provide insight into landscape-scale retention patterns of reef fishes.

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THE PAST, PRESENT AND FUTURE OF CORAL REEFS: A FUNCTIONAL PERSPECTIVE. (Abstract ID: 28502)

Our view of the evolution of coral reefs, and fishes in particular, has been largely based on changes in the diversity of taxa. The fossil record places taxa at particular locations and points in time, while phylogenies identify relationships and the timing of divergence events. It is only when these data are considered in a functional context that we can begin to reconstruct the ecology of past reefs. The overarching goal of our research has been to develop a picture of ancient reefs as working functional ecosystems. In this way we can examine changes through time in terms of how reefs operated, rather than documenting the diversity of key lineages. In this presentation I will provide an overview of our recent research on the evolution of major functional traits in reef fishes, detailing how these traits influence the use of reefs by fishes, and how reefs have changed as a consequence. I will also examine the implications of these changes for the future of coral reefs at a global scale. Remarkably, the future of coral reefs appears to be returning to a distant past. Human activities are selectively undermining the last 30 million years of coral reef evolution, producing reefs that closely resemble their ancient counterparts.

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ENVIRONMENTALLY MEDIATED MATERNAL EFFECTS IN STYLOPHORA PISTILLATA FROM THE GULF OF AQABA, RED SEA. (Abstract ID: 29387 | Poster ID: 482)

It is typically reported that 1°C above the local maximum monthly mean (MMM) sea temperature can result in coral bleaching. Despite increasing sea temperatures in line with the global rate, and recurring positive temperature anomalies, coral bleaching is rarely reported in the Gulf of Aqaba, Red Sea (GoA). Experiments conducted with the locally important *Stlyophora pistillata* sustained for 2 weeks at 5°C above MMM, resulted in few of the common bleaching signs. As a result, the GoA has been putatively identified as a refuge and a potential donor site for assisted colonisation and restoration projects. However, this prospect depends upon the continued ability for local species to adapt to further change and pass on favourable traits to enhance offspring fitness. The link between adult health and parental investment is not well understood in corals. Therefore, field sampling and experiments were conducted to investigate how the environmental experience of the parental colony influences offspring traits and how this may affect recruitment in future oceans. *S. pistillata* has colonised diverse habitats in the GoA and planulates throughout the entire regional sea temperature range (21 – 29°C). This offers

a rare chance to assess planulae fitness across *in situ* and experimental environmental gradients. Results from these studies give insights into how offspring viability is environmentally mediated and offers considerations for active restoration projects.

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WATER SECURITY IN SMALL ISLAND DEVELOPING STATES: APPLYING A MULTI-SCALAR GOVERNANCE LENS TO ELUCIDATE POTENTIAL FOR 'TRANSFORMATION' (Abstract ID: 28251 | Poster ID: 557)

Water security is one of the most pressing development challenges of the Anthropocene, epitomized by the recent adoption of a dedicated water goal in the post-2015 development agenda. This agenda aims to 'transform our world'. Fundamental to such a transformation are water governance reforms. Indeed, many researchers and water management practitioners have called for a paradigm shift away from top-down command and control management towards adaptive water governance in order to enable transformation. Yet there has been limited research into the potential for such transformations in SIDS— contexts, which we argue are peculiar, and deserving of special attention. To address this gap, this paper utilizes a multi-scalar governance lens to interrogate water sector reforms in Samoa (the Pacific) and St. Lucia (the Caribbean). The multi-scalar governance lens elucidated how the actually existing complex water governance systems have arisen over time, through processes of contestation and struggle between actors at multiples scales, to fit the specific geophysical, political and cultural contexts in two case studies. The results also illustrate how, even in the unique socio-political contexts in SIDS, where state-society relations are often blurred, formal hierarchies are sometimes ill-defined, and informal relations between actors can act as limitations, there exist immanent opportunities for transformative change towards more adaptive and socially-just governance.

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IMPROVING LONG-TERM CORAL REEF MONITORING IN THE WIDER CARIBBEAN REGION: INITIAL GCRMN-CARIBBEAN ACCOMPLISHMENTS (Abstract ID: 28385)

Long-term and robust coral reef monitoring coupled with strategic reporting are essential drivers for ecosystem-based management and regional policy processes. The Global Coral Reef Monitoring Network (GCRMN) report*Status and Trends of Caribbean Coral Reefs 1970-2012* highlighted the limitations of regional coral reef monitoring in the Caribbean. To address the urgent need for more effective coral reef monitoring and reporting there has been a move towards revitalizing the Caribbean component of the GCRMN. The foundation for restructuring the network was launched in August 2014, along with concrete proposals for improvements in data collection, archiving and communication. Several technical and scientific solutions have been proposed to address the lack of information and dissemination, and inconsistency in applying monitoring methods and approaches throughout the region. The first two years of the GCRMN-Caribbean has seen the confirmation of a dynamic network, which has been bolstering its presence and regional acknowledgement. An expert steering committee and members-at-large have enabled the network to achieve substantial progress. GCRMN-Caribbean integrated guidelines have been improved and tested at several sites; communication and experience sharing have increased considerably; capacity building actions have been identified and developed; and there has been collaboration with major Caribbean programmes. This paper reports on the progress towards revitalizing the GCRMN-Caribbean, its initial achievements, as well as network challenges and next steps.

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EFFECTIVE DISPERSAL OF CARIBBEAN REEF FISH IS SMALLER THAN CURRENT SPACING AMONG MARINE PROTECTED AREAS (Abstract ID: 29826)

Coral reefs are deteriorating at a fast pace. Conservation measures, such as Marine Protected Areas, have been implemented to relieve some areas from local stressors and allow populations to restore to natural levels. Successful networks of MPAs can operate if the space among MPAs is smaller than the dispersal capacity of the species under protection. Here we tested the power of genome-wide Single Nucleotide Polymorphism data to estimate connectivity across populations in a series of MPAs around Puerto Rico and contrasted with 18 microsatellite markers. We found that in the common yellowhead Jawfish, *Opistognathus aurifrons* the maximum effective dispersal is 10 km. MPAs exchange migrants likely via intermediate available unprotected habitats through stepping stone dispersal. At scales > 100 km such connectivity is decreased, after the Mona Passage, making the Dominican Republic a genetic mosaic of the genetic variation from the eastern and western Caribbean. The MPA network studied is unable to maintain adequate levels of connectivity of these small benthic fishes if habitat in between them is extirpated. Given that overall reef fish diversity is driven by species with life histories similar to that of the yellowhead jawfish, managers face a challenge to develop strategies that allow connectivity and avoid isolation of populations and their extinction.

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FISHING FOR ANSWERS: TRACKING YELLOWTAIL (*SERIOLA LALANDI*) MOVEMENTS AND CATCH IN THE EASTERN PACIFIC. (Abstract ID: 29871 | Poster ID: 271)

Yellowtail (*Seriola lalandi*) are large, carangid, meso-predators that migrate between sub-tropical and temperate reef systems along the North American west coast. They are seasonally abundant, corresponding to regionally elevated sea-surface temperatures; increased catches occur during periods of warm water or ENSO conditions. However, analysis of recreational catch data suggests the largest (>13 kg) individuals inhabit nearshore waters year-round. These observations suggest a structured pattern of space-use based upon physiological constraints and ontogenetic movements, with the potential for novel northward range expansions under conditions of ocean warming. This work is the first since 1960 on this widely targeted, economically important species. To examine spatial and temporal trends in the fishery, all recreational catch in southern California between 1936-2015 from all existing databases were analyzed by size, season, location, and sea-surface temperature. Catch was bi-modal with peaks at both immature and mature sizes, larger fish were caught inshore (<3 mi) while smaller fish were predominantly offshore (>3 mi). These trends varied predictably depending on season. Fish caught during winter were significantly larger than those caught during the remainder of the year. These trends motivated a comprehensive regional tagging program. Currently, the recapture rate is 21%, with time at liberty ranging from 24 hours to 24 months and recapture distance from 0-400km and suggests novel evidence of ontogenetic changes in movement.

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GLOBAL PATTERNS OF FUNCTIONAL RARITY IN REEF FISH COMMUNITIES (Abstract ID: 29630)

The loss of biodiversity caused by human-mediated impacts has reached unprecedented level across all ecosystems, with rare species being by far the most threatened. Despite the importance of biodiversity to sustain ecological processes, little is known about the particular functions supported by rare species or the functional vulnerability of communities to rare species loss. Thus, assessing the spatial distribution of functional rarity would provide relevant information to the conservation of the most vulnerable species and communities within the context of intense disturbances and high uncertainty. Our extensive dataset comprised local abundances, regional occupancies and functional traits for 1,474 reef fish species. We assessed global patterns of functional rarity and implemented scenarios of functional diversity loss across 93 reef fish communities distributed across five marine biogeographic regions. We found that rare species fulfil much of the range of functional traits within reef fish communities and often perform unique roles. We identified high functional diversity erosion from rare species loss in the majority of reef fish communities, this level reaching up to 70% of functional diversity in one location. Also, rare species carry the most distinct combinations of functional traits (high distinctiveness), whereas species with low functional distinctiveness are either locally rare or common. Our results highlight the vulnerability of ecological roles supported by rare species, even in highly diverse reef fish communities.

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TEMPORAL CHANGES IN THE PRODUCTIVITY AND CALCIFICATION OF SLOPE AND LAGOONAL BENTHIC COMMUNITIES ON A PLATFORM REEF (Abstract ID: 29275)

More than a quarter of a century ago, pioneering studies assessing the metabolism of coral reef communities were conducted in order to better understand the workings of

these beautiful, yet complex ecosystems. Today, studies revisiting in-situ measurements of coral reef metabolism are still very important as (i) technology has progressed and offers more precise measuring techniques and (ii) reef systems are changing through anthropogenic influences. The aim of our study was to investigate the metabolism of reef communities of 2 distinct geomorphological zones on a platform reef in the Great Barrier Reef, Australia. The sites, one at 5m on the reef slope and the other inside the lagoon, were continuously monitored for water depth, temperature, oxygen, light, $CO_2$, pH, turbidity, salinity and chlorophyll concentration using CTDs. Four times a year, in every season, in-situ incubations were conducted at both sites using computer controlled Perspex chambers connected to an autosampler. Importantly, two sides of the chambers opened between incubations to allow for water exchange and prevent depletion of nutrients/ions. Productivity, measured as oxygen flux, and calcification rates were established for representative benthic communities inside these chambers. Preliminary results suggest that there is a temporal effect on reef productivity and calcification. The findings of these incubations will also be discussed in light of the background water quality measurements.

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PROGRESS TOWARD ACHIEVING SETTLEMENT AND METAMORPHOSIS OF AIPTASIA LARVAE IN THE LABORATORY (Abstract ID: 28961 | Poster ID: 200)

As the sea anemone Aiptasia gains traction as a model for investigating cnidarian-dinoflagellate symbiosis, a remaining obstacle is the inability to reproduce the complete sexual life cycle in the laboratory. Although we can obtain regular spawning and larvae production in the lab, the physical and/or chemical cues required for larval settlement and metamorphosis remain elusive. Here we report progress on two fronts: (1) identification of inductive natural products and/or bacterial isolates; (2) identification and application of neuropeptides with a role in metamorphosis. Tetrabromopyrrole, a natural product from the marine bacterium Pseudoalteromonas spp. that induces settlement and metamorphosis in coral larvae, and a Hydra neuropeptide (Hym248) each induce partial metamorphosis of Aiptasia without settlement. We are currently attempting to identify bacteria or extracts that will reliably induce both settlement and metamorphosis. To identify Aiptasia LWamide neuropeptides that might induce settlement and/or metamorphosis, we performed a thorough screen of the Aiptasia genome and available transcriptomes. At least seven putative LWamide-like neuropeptides occur in the genome and are also found in adult or larval transcriptomes. Four of these contain the "GLW" motif conserved in proteins from other cnidarians (e.g., Hym-248 from Hydra; Metamorphosin A from Anthopleura); three others, including one expressed exclusively in Aiptasia larvae, contain repetitive "GIW", "GVW" or "GFW" motifs. We are currently testing the possible roles of these neuropeptides in metamorphosis.

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MARINE CONSERVATION & RESOURCE MANAGEMENT YOUTH EDUCATION - A MISSING STRATEGY IN FUTURE CORAL REEF RESILIENCE IN THE CORAL TRIANGLE? (Abstract ID: 27856)

In 1997, in a local high school in the West New Britain Province of Papua New Guinea, a volunteer biology sciences teacher commenced the development of the Marine Environment Education Program, or MEEP. With technical input from James Cook University, Australia and experienced educators, the program now reaches elementary, primary and high schools, both locally and on a wider national scale. The principal aim of the program is to help educate the country's youth in marine conservation and resource management. The course compliments PNG Department of Education primary & secondary curricula in biology and environmental sciences while exposing students to actual field visits to coral reefs and other marine ecosystems. MEEP has now been thoroughly field tested within Coral Triangle conditions, marine environments and communities, and is further evolving even after a period of 19 years. With this background and historical development, is there a more co-ordinated approach for marine conservation and resource management youth education within the Coral Triangle by all CT countries? Can MEEP be part of a solution to coral reef resilience? The future of marine resource management within this region will depend in part on the present and future youth generations and their understanding of sustainable use of their marine resources. Is it time for more Coral Triangle countries to engage in this strategy for future resilience of coral reefs? Mahonia Na Dari Research and Conservation Centre (Guardian of the Sea), Kimbe Bay, PNG where the program is based, believes it is.
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NON-CONSUMPTIVE EFFECTS OF NATIVE AND INVASIVE PREDATORS ON RECRUITMENT OF CORAL-REEF FISHES (Abstract ID: 28838)

Coral-reef fishes are particularly susceptible to predation during their transition from pelagic larvae to reef-associated juveniles. Larvae of some species detect cues from predators and avoid settling nearby. However, it is unknown whether recruits alter their settlement habitat in response to invasive predators and how other potentially mediating factors, including predator diet and interactions among conspecific recruits (e.g., competition, facilitation), influence these patterns. We conducted manipulative field experiments to test for non-consumptive effects of native and non-native predators on the settlement of Caribbean coral-reef fishes. There was no effect of predator presence or conspecific density on the recruitment of bicolor damselfish (*Stegastes partitus*) to standardized patch reefs. In contrast, there were ~52% fewer mahogany snapper (*Lutjanus mahagoni*) recruits to reefs with a native predator (graysby grouper, *Cephalopholis cruentata*) compared to predator-free control reefs and reefs with an invasive predator (red lionfish, *Pterois volitans*) regardless of predator diet. These results suggest that snapper recruits may use species-specific cues to recognize native predators and are naïve to cues from an invasive predator. However, on nights with extremely high recruit densities there was approximately equal recruitment of snapper to all reefs regardless of predator presence, suggesting that intraspecific interactions among recruits may limit the non-consumptive effects of predators at high conspecific densities.

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MODEL FOR SUSTAINABLE HARVEST TO ASSIST COMMUNITY-BASED RESOURCE MANAGEMENT (Abstract ID: 29698)

Fisheries worldwide are in decline due to exploitation, anthropogenic pressures, habitat loss, and changes in climate. Here, we present a single-species assessment model that uses resource monitoring data collected by the 'Opihi Partnership, which involves communities, scientists, NGO, and GO, to evaluate the ability to sustainably harvest 'opihi (*Cellana spp*., limpets) at different times and locations. 'Opihi are culturally and economically valuable to the Hawaiian Islands and its people, so it is imperative to ensure that this fishery is sustainable. The life history characteristics of 'opihi are used to build assumptions into the model regarding spawning characteristics, growth rates, and size at reproductive maturity. The model accepts 'opihi size distribution and population density data and returns a recommendation of whether harvest, under current legal regulations, would be offset by the maturation of juvenile 'opihi. We then tested the model with data from 'opihi makaiauli (*Cellana exarata*) from two islands, Mokupāpapa and Mokumanamana, in the Papahānaumokuākea Marine National Monument (PMNM), which are ideal because neither is subject to harvesting. The model predicts that when challenged with unrestricted harvest within the legal size limits, the recruitment-limited site could not sustain harvest and the recruitment-saturated site can only sustain seasonal harvest. There is also the potential for this model to extend to other broadcast spawners such as sea urchins, mussels, abalone, clams, and oysters.

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CHANGE DETECTION IN A CORAL REEF ENVIRONMENT IN THE ARABIAN GULF USING MULTISPECTRAL REMOTE SENSING (Abstract ID: 28583)

The United Arab Emirates (UAE) borders the Arabian Gulf. The coasts and islands that flank Abu Dhabi, the UAE's largest emirate, host important marine habitats such as coral reefs. These reefs are subject to pressures from urban and industrial encroachment and from climate change. The current study aims to detect the change in a reef environment of Dalma Island, located 42 km off Abu Dhabi, between 2013 and 2015. Satellite remote sensing-based monitoring of such ecosystem presents a challenge due to the attenuation of light through the atmosphere and the water column, as well as the spectral similarity of its benthic components. Our method proposes a combination of different remote sensing techniques that include image segmentation, non-linear feature analysis (kernel feature extraction) and ensemble learning methods (Random Forest); consisting of spectral-spatial methods vs. pixel-based methods. Change detection is fulfilled using the Iteratively Reweighted Multivariate Alteration Detection method that performs an automatic radiometric normalization and factors out the side effects of varying acquisition conditions. The achievement of the adaptation of these methods to the region of concern demonstrates the operational role of multispectral remote sensing in coral reef monitoring.

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THE EFFECT OF FLUORESCENT PIGMENTS DIVERSITY ON UV INDUCED DAMAGES IN HERMATYPIC CORALS (Abstract ID: 28654)

Solar radiation includes both vital photosynthetic active radiation (PAR), and harmful ultra-violet radiation (UVR). Corals at the photic zone are exposed to UVR that induces different physiological damages including two abundant DNA lesions: cyclobutane pyrimidine dimers (CPDs) and 6-4 photoproducts (6–4PPs). Such DNA damage may lead to cell death and coral degradation. Coral reefs are known to poses a variety of fluorescent proteins (FPs), which are extensively used as visual markers in biomedical research, yet, their biological function is still poorly understood. Whereas it has been shown that FP production is influenced by light and, therefore, provides photoprotection against radiation (whether UVR or PAR), the role of fluorescence in preventing direct DNA damage has not yet been studied. In this study, different natural fluorescent morphs of the same coral species, coupled with translocation experiments and observations both in-situ and ex-situ were used in order to investigate the changes in coral fluorescence and UVR protection abilities. We characterized excitation and emission spectra of different FPs, quantified fluorescence levels, and analyzed UVR induced DNA damage in both host and algal symbiont. We found that the expression of fluorescence can change under different light regimes (either by photoconversion or expression levels) and that UVR induced DNA damage varies in relation to the coral's FP arsenal, thus, suggesting that a certain FP might give an advantage is UVR exposed environments.

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SPATIAL AND TEMPORAL VARIATION IN NEAR-SHORE MARINE ASSEMBLAGES AROUND THE US VIRGIN ISLANDS (Abstract ID: 29392 | Poster ID: 315)

While many Caribbean marine habitats have degraded in recent decades due to Diadema outbreaks, excess nutrients, coral bleaching, overfishing etc., most attention has been given to larger off-shore reef habitats. However, coastal near-shore marginal habitats interspersed with corals can support high biodiversity including juveniles of many coral-reef species. These habitats are especially prone to human-caused degradation and often are the ones most visited by tourist and arguably are an equally important tourism asset and potential nursery. We report here on a study conducted in 2003/4 and followed up in 2013 on the benthic habitat cover at sites adjacent to St. John and St. Thomas, US Virgin Islands. With the help of Earthwatch volunteers, we enumerated rocky habitat cover types and distribution and size of benthic fishes and how this related to changes in coral and other live cover. Overall coral cover declined at all sites between 2004 and 2013 although there was minor recovery of some species (e.g. *Acorpora palmata*and *Millepora spp*.). Some fish species abundances seem to be tightly linked to changes in coral cover (for instance the three-spot damselfish *Stegastes planifrons* seemed to follow changes in *M. annularis* abundance among sites and through time). We will briefly touch on the costs and benefits of citizen science data acquisition and among site and across-decade trends in the above benthic characteristics.

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PREVALENCE OF POACHING BY RECREATIONAL FISHERS IN THE GREAT BARRIER REEF MARINE PARK, AUSTRALIA (Abstract ID: 27795)

Though the Great Barrier Reef Marine Park is widely considered the best managed coral reef in the world, law enforcement records show a rapidly increasing trend in detected offences and non-compliance by recreational fishers. However, the actual level of illegal fishing by recreational fishers is currently unknown, as are the reasons for why recreational fishers poach (i.e. fish in no-fishing zones). Here, we estimate poaching by recreational fishers in no-fishing zones of the Great Barrier Reef Marine Park, Australia using a mixed methods approach. Specifically, we surveyed 265 fishermen and conducted 60 underwater visual censuses to quantify discarded fishing gear inside and outside no-fishing zones. Our study revealed three key results: 1) the level of non-compliance among fishers is between 3 and 18%; 2) poaching activities were often concentrated in poaching hotspots; and 3) the highest rated perceived motivations to poach were because fishing is better in no-take zones, and a low probability of detection. Thus, efforts to reduce poaching in no-fishing zones via the information deficit communication model (i.e. telling fishermen that green zones work) are unlikely to reduce poaching activities. Overall, our results indicate a rising trend of recreational fisher non-compliance that could threaten the efficacy of one of the world's best-managed marine protected areas.

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POSITIVE SELECTION AND DIFFERENTIAL GENE EXPRESSION SUPPORT ECOLOGICAL SPECIATION BETWEEN THREE SYMPATRIC SPECIES OF GRUNTS (GENUS: HAEMULON) (Abstract ID: 28717)

Understanding the genomic basis of adaptation is essential for discerning how divergence takes place. This is particularly relevant for groups conformed by sympatric species that have broad geographic ranges. This is the case of the genus *Haemulon*, where five species pairs overlap in the Tropical Western Atlantic. Here we studied the transcriptomes of three closely related species of grunts: *H. carbonarium*, *H. flavolineatum* and *H. macrostomum*. Branch-sites models revealed over one hundred orthologs under strong positive selection, while gene expression assays identified 1258 differentially expressed genes between the three species. Moreover, 43 genes were found to be both under positive selection and differentially expressed. Major differences were found in genes related with signal transduction, metabolic pathways, gene regulation and reproductive traits. Positive selection was also found in the FGF1 gene, which is related with the development of the feeding apparatus in fishes. Considering that overlapping species of grunts are known to have dietary partitions, and that these correlate with differences in feeding structures, this study supports the case for ecological speciation in the genus *Haemulon*.

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SPATIO-TEMPORAL CHANGES OF THE REEF COMPLEX OF PROVIDENCE ISLAND, COLOMBIAN CARIBBEAN: AN ASSESSMENT FROM THE SEASCAPE PERSPECTIVE (Abstract ID: 28117)

Changes in coral reefs composition, richness, and distribution are not easy to quantify in most reef systems. This is the case of the reef complex of Providence Island because the limited spatial and temporal coverage of the traditional monitoring programs do not allow observing changes at seascape level. We assessed those seascape units (SU) changes within this shallow reef complex by comparing two satellite images: Ikonos (2000) and Quickbird (2012). The SU were classified by an object oriented method, and validated using field points. We found that 90% of the SU became fragmented or transformed after 12 years, mainly in the west. The SU composition changed due to macroalgae and cyanobacteria dominance and the local extinction of corals. This led to an increase in SU richness, but with time spatial homogeneity will prevail. A decrease in the extension of the SU dominated by corals was evident: two SU with live coral cover >30% disappeared due to the death of Acropora and the increase of cyanobacteria. To the east and south, the SU were fragmented and transformed to other SU that had more macroalgae than calcifying organisms. These shifts led to a loss of 10.4% of coral reef area and 37.7% of live coral (3.2% annual mortality rate). The results show that the reef complex has deteriorated, losing its calcifying potential due to the replacement of live coral by macroalgae, cyanobacteria and dead coral. This will lead to a decrease in coral accretion, biodiversity and ecosystem services. Satellite analysis gives us a better tool to understand the magnitude of reef changes.

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GENOMIC SIGNATURES OF PRE-ADAPTATION AND POST-INVASION RAPID ADAPTIVE EVOLUTION IN THE BLUESPOTTED CORNETFISH, A MEDITERRANEAN LESSEPSIAN INVADER (Abstract ID: 29913)

Biological invasions are increasingly creating ecological and economical disasters both on land and in aquatic environments. For over a century, the Mediterranean Sea has steadily been invaded by Red Sea species (called Lessepsian invaders) via the Suez Canal, with a current estimate of approximately 450 species. The bluespotted cornetfish, *Fistularia commersonii*, considered a "Lessepsian sprinter", entered the Mediterranean in 2000, and by 2005 had invaded the entire basin from Israel to Spain. The situation is unique and interesting both because of its unprecedented rapidity, and by the fact that it took this species approximately 130 years to migrate from the Red Sea into the Mediterranean. Using genome scans, with restriction site associated DNA (RAD) sequencing, we evaluated neutral and selected genomic regions for Mediterranean vs. Red Sea cornetfish individuals. We found that little neutral changes were detectable among populations.

However, almost half of the genes associated with the 47 loci under selection were related to disease resistance and osmoregulation. Due to the short time elapsed from the beginning of the invasion to our sampling, we interpret these changes as signatures of pre-adaptation, where Red Sea individuals that carried those traits were primed to successfully invade the Mediterranean. Such genomic regions are therefore good candidates to further study their role in invasion success.
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MORPHOMETRIC AND GENETIC DIFFERENTIATION OF ACANTHOCHROMIS POLYACANTHUS IN THE PHILIPPINES (Abstract ID: 29240 | Poster ID: 187)

Acanthochromis polyacanthus (spiny damselfish) is a model organism in dispersal for its lack of pelagic larval stage. Performance differences have been attributed to divergence in morphological traits among population. Genetic analyses have also documented the differentiation in Acanthochromis polyacanthus across color morphs and within color morphs from different populations in Australia. In this study, we explored the morphometric and genetic differentiation of spiny damselfish in the Philippines. Principal component and multivariate analysis of variance at 20 landmark points were evaluated for 160 individuals from Davao del Norte, Davao Oriental, Sarangani, and Batangas. Geometric morphometrics by generalized procrustes analysis revealed morphological disparities among populations. Genetic analysis of the COI gene from a subset of 73 individuals also reveals variation across the 4 populations. Our results suggest that Acanthochromis polyacanthus in the Philippines can be differentiated per population. The absence of pelagic larval stage may have attributed to the significant morphological and genetic differences among populations. However, since there is no obvious mechanism for dispersal for this species, whether this divergence is a result of a plastic response to environment or genetic adaptation remains a mystery. Keywords: Acanthochromis polyacanthus, morphometrics, COI gene

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EFFECTS OF UNBURNT COAL DUST ON A CORAL, REEF FISH, AND SEAGRASS SPECIES (Abstract ID: 29570 | Poster ID: 466)

Thousands of coal loaded vessels, carrying up to 150,000 t of coal regularly transit through coral reef ecosystems in Australasia, the Indo-Pacific and Caribbean regions each year. Coal particles and dust are physically abrasive, block light penetration into the water column and contain potentially toxic hydrocarbons and trace metals. Consequently, reef organisms such as corals, can be at risk from suspended and deposited coal particles that might result from ship loading or spill events. Despite this risk, the effects of suspended and deposited coal on tropical marine organisms of high conservation value remains largely unknown. This study conducted a series of controlled experiments exposing three taxa abundant in tropical marine ecosystems (the coral *Acropora tenuis*, the reef fish *Acanthochromis polyacanthus*, and the seagrass *Halodule uninervis*) to a range of suspended coal dust (< 63 µm) concentrations (0-275 mg/L) over 28 d. Results demonstrate that chronic coal exposure can cause considerable lethal effects on corals, and reductions in seagrass and fish growth rates. Coral survivorship and seagrass growth rates were inversely related to increasing coal concentrations (≥ 38 mg/L) and effects increased between 14 and 28 d, whereas fish growth rates were similarly depressed at all coal concentrations tested. This investigation provides novel insights into direct coal impacts on key tropical taxa for application in the assessment of risks posed by increasing coal shipments in globally threatened marine ecosystems.

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WHY DOES THE RED SEA REGION HAVE SO MANY ENDEMIC SPECIES? AN EVOLUTIONARY AND ECOLOGICAL CONNECTIVITY PERSPECTIVE (Abstract ID: 29725)

The Red Sea and seas of the Arabian region represent a unique environment with strong latitudinal gradients in water temperature, salinity, and nutrient load that may act as ecological barriers to larval dispersal and the eventual settlement of marine fauna. We conducted broad-scale surveys of reef organisms employing modern taxonomic (i.e., integrated molecular and morphological studies) and phylogeographic approaches at multiple sites throughout the region. This presentation will explore which groups of reef-associated animals have high levels of endemism in the region. Establishing patterns of biodiversity and biogeography in the Arabian region is one of the first steps towards understanding the underlying drivers of adaptation to the unique Arabian environments. For some taxonomic groups, we have also explored genetic and genomic patterns to help understand how the distributions of these organisms originated, how the distributions are maintained, and the capacity that various population have for adaptation to continued global change. The findings also shed light on ecological and evolutionary connectivity patterns. Future work will integrate local larval dispersal observations, species distributions, genetic data, and large-scale oceanographic models to further understand the role of the Red Sea in the general context of Indo-Pacific biogeography.

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LETHAL AND SUB-LETHAL IMPACTS OF DREDGE RELATED STRESSORS ON CORALS (Abstract ID: 28529)

The impacts of sediments on coral reefs are under intense scrutiny, with increased coastal development globally. Numerous dredging operations have facilitated this development and can generate large quantities of suspended sediments that can affect nearby coral populations. Sediments released into the water column result in three proximal stressors to corals; firstly the suspended sediment can clog filter feeding apparatus, secondly it attenuates light, reducing levels available for photosynthesis, and lastly it may fall out of suspension and smother corals. In order to appropriately manage the impacts of dredging-related stressors on corals, cause-effect pathways followed by dose-response relationships need to be determined. A series of experiments were conducted to partition the impacts of suspended sediment and light attenuation on coral, and then determine low light thresholds for corals. These experiments have provided insight into the impacts on a suite of health indicators including mortality, colour, chlorophyll fluorescence, respiration rates, along with chlorophyll and lipid concentrations, providing information on both lethal and sub-lethal impacts. These experiments have determined that light is the major stressor on coral health rather than suspended solids, and that extended periods of reduced light are detrimental to coral health for both adults and juveniles. These results demonstrate that, excluding sediment deposition, measuring light levels is an effective way to monitor the stress on reef corals during dredging projects.

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HORMONAL TRIGGERING OF CORAL REEF FISH METAMORPHOSIS (Abstract ID: 29992)

In coral reef fish, the larva to juvenile transition occurring while recruits colonize the reefs has been acknowledged as a metamorphosis for more than 70 years. Indeed, this shift from pelagic to benthic life is accompanied by major changes suited to the new reef environment. However, physiological and hormonal processes that could occur and trigger this transition remain unknown in coral reef fish. Here, we hypothesized that thyroid hormones (TH) are triggering coral reef fish metamorphosis, as evidenced in temperate and commercial fish species like flatfishes and sea breams. By capturing larvae at their arrival into the reefs of Moorea, French Polynesia, we observed a TH peak at metamorphosis in a surgeonfish, Acanthurus triostegus, and a batfish, Platax orbicularis. We also showed a TH decrease in 3 other species from different families, suggesting that their TH peak may occur before reaching the reefs. In A. triostegus, neuromast development and guts lengthening were observed along metamorphosis. Daily hormonal treatments on A. triostegus recruits exhibited that enhancing the TH pathway leads to both early neuromast development and early gut lengthening, while interrupting this pathway leads to delays in these changes. Overall, these results suggest that coral reef fish metamorphosis seems to be a classical TH-triggered metamorphosis. Knowing the ability of pollutions like pesticides to disrupt such endocrinal processes, it is of great interest to better characterize this metamorphosis facing global change and its importance in larval recruitment.

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COLLATERAL DAMAGES OF THE CORALLIVOROUS GASTROPOD DRUPELLA CORNUS ON CORAL MICROBIAL ASSOCIATES (Abstract ID: 28573 | Poster ID: 147)

The grazing activity by specific marine organisms represents a growing threat to the survival of many scleractinian species. For example, the recent proliferation of the corallivorous gastropod Drupella cornus now constitutes a critical case in all South East Asian waters. If the damaging effects caused by this marine snail on coral polyps are relatively well known, the incidence of grazing on coral microbial associates might also potentially impair the defense mechanisms and nutritive properties of their bacterial and viral epibionts. In this study, we tentatively compared the main ecological traits of coral-associated bacterial and viral communities living in the mucus layer of Acropora formosa and Acropora palmata, between healthy and predated individuals (ie colonized by D. cornus), in the Bay of Nha Trang (Vietnam). Although some samples are still under analysis, preliminary results seem to show a substantial impact of the presence of the gastropod on a variety of ecological markers (abundance, diversity, respiration, metabolic capacity, life strategy, etc.) for both viral and bacterial communities, whatever the species considered. Finally, our results suggest that predation, beyond its direct deleterious mechanical effects to corals, might be also able to cause significant alterations in their symbiotic microbiota, which may subsequently promote the emergence of opportunistic pathogenic infections.

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INVESTIGATING ACUTE *MONTIPORA* WHITE SYNDROME: POTENTIAL CAUSATIVE AGENTS, ENVIRONMENTAL DRIVERS, AND THE IMPORTANCE OF CORAL HEALTH (Abstract ID: 28131 | Poster ID: 153)

Disease is a threat to coral reefs and exacerbates the widespread impacts of climate change. Moreover, environmental stressors can increase prevalence of coral diseases. Outbreaks of the tissue loss disease acute *Montipora* white syndrome (aMWS) have occurred in *Montipora capitata*, a major reef-building coral in Kaneohe Bay, Hawaii, which may have been triggered by sewage runoff associated with rainfall and pre-existing stress from a chronic tissue loss disease (cMWS). One of the potential etiological agents of aMWS is *Pseudoalteromonas* sp. OCN003, a strain isolated from diseased *M. capitata*. Under controlled conditions, 20% of the healthy fragments exposed to OCN003 developed acute tissue loss within 3 weeks post-inoculation. When fragments already compromised by cMWS were exposed to OCN003, 60% of the fragments switched to acute tissue loss within 4 days post-exposure. Thus, OCN003 is more successful as a secondary pathogen in laboratory experiments. Infections of cMWS are observed year-round, while aMWS outbreaks have only occurred during the rainy winter months. Bacterial communities of samples from healthy and diseased *M. capitata*during an aMWS outbreak were analyzed with high-throughput sequencing. Sequences from the family Enterobacteriaceae dominated all samples, which were similar to species that inhabit the human gastrointestinal tract, suggesting sewage and/or freshwater input. This study describes the first*Pseudoalteromonas* sp. pathogenic to coral and possible bacterial communities consistent with anthropogenic stressors associated with a fatal coral disease.

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SHIPPING AND MARINE PILOTAGE: ARE THERE SUFFICIENT SYSTEMS IN PLACE TO PROTECT VULNERABLE MARINE ECOSYSTEMS? (Abstract ID: 29946)

Like other vulnerable marine ecosystems, many coral reefs are situated in areas adjacent to busy shipping routes and ports. High risk-industries, including those carrying risks to the marine environment such as oil extraction and shipping, require many layered controls in place in order to prevent catastrophic accidents. Accidents can cause widespread environmental damage, as well as economic costs and loss of human life. We still do not fully appreciate the long-term impacts of catastrophes such as the grounding of the Exxon Valdez in Alaska, and the Deepwater Horizon oil spill in the Gulf of Mexico. One risk control employed by the shipping industry is marine pilotage – the utilization of an experienced mariner familiar with a local area to direct itinerant foreign or unfamiliar vessel's crew through the hazardous and dynamic environments of ports, coastlines, and reefs. The organization and engagement of marine pilots varies at national and international levels, influenced by many factors including regulatory frameworks and legislation. Here we present the usage of coastal pilots in the Great Barrier Reef for the central benefit of shipping safety and environmental protection. With projected growth in shipping traffic, we discuss strengths and limitations of the current system. Catastrophic accidents in sensitive marine areas can have severe and lasting impacts, thus a zero-accident goal requires a different approach to more conventional risk or exposure management.

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WHICH FACTORS DRIVE CORAL REEF FISHERIES: ECONOMICS, ENVIRONMENT OR RANDOMNESS? (Abstract ID: 28104 | Poster ID: 265)

Coral reef environments support a significant proportion of commercial fishing activities, and are very important for the small-scale sector. These fisheries are essential for income generation and food security of millions of people. Importantly, the targeted reef species are associated with higher market values when compared to fishing resources in other habitats. In addition, this resource are easy to access, making them less costly to catch. Hence, the main goal of this study is to identify the main drivers of reef fisheries for the small-scale sector. This knowledge is useful for developing effective management plans that can economically benefit the fishers while ensuring the sustainability fish and fisheries. A time series of landing data was used jointly with ex vessel price data and environmental variables to conduct our analysis. Multivariate and Bayesian analysis are performed to evaluate the possible association between species habitat and economic factors. Specifically, we investigated the link between the temporal variation of important commercial reef fish abundance, their ex vessel fish price and the associated environmental characteristics of the coral habitats. If it turns out that coral reef fisheries are driven mainly by economic factors, managers will be able to choose a management instruments, for instance, the use of seasonal closure carefully. On the other hand, if environmental factors were more important, then climate change mitigation, for instance, will become a bigger issue for managers' to deal with in order to better protect reef fish supply.

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PERCEPTIONS IN SMALL ISLAND MARINE RESOURCE MANAGEMENT (Abstract ID: 28003 | Poster ID: 594)

Transformation to sustainable lifestyles demands integrative, inter- and transdisciplinary approaches of science and stakeholder engagement. In these processes perceptions, values and social norms play key roles in shaping behavioural outcomes. Often, environmental degradation and its far reaching impacts are consequences of human behaviour such as environmental pollution and resource overuse. Understanding collective human behaviour is thereby key for tackling global challenges. Taking the example of community- based marine resource management (CBMRM), this paper combines ecological and psychological views on the challenges of participatory processes and calls for an explicit integration of behavioural science expertise in transformational endeavours. Societies and ecosystems do not change independently from each other, hence, a truly transdisciplinary and workable approach is necessary whenever human beings aim at sustainable interactions with ecosystems. This paper dissects factors that affect stakeholder perceptions, pathways and interpretations of information, and how these shape social norms, and translate into behaviour. In making these factors explicit, we aim for a workable approach for people working in sustainable resource use and management.

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MITIGATION OF THERMAL AND LIGHT STRESSERS ON A MAURITIAN REEF BY TROPICAL CYCLONIC CONDITIONS (Abstract ID: 29532)

Coral reef ecosystems are threatened due to global warming leading to widespread coral bleaching. This study examined coral bleaching over 3 months (November to January) during 3 years (2010-2013) in the dominant coral species, *Acropora muricata*, within the coral reefs of Belle Mare, Mauritius in the South Indian Ocean at a finer scale including three zones, namely near the coast (Z1), in the middle of the lagoon (Z2) and on the reef flat (Z3). Data loggers were deployed next to the monitored coral colonies to record *in situ* temperature and light levels. For the periods November 2010 – January 2011 and November 2011 – January 2012, higher prevalence of temperatures above 30°C and 31°C occurred at Z1 than Z2 and Z3. However, bleaching occurrence was reversed, i.e., *A. muricata* colonies did not bleach at Z1 but bleached, starting in November, at Z2 and Z3. During November 2012 and January 2013, temperature and light recordings were lower and almost no coral bleaching occurred compared to the previous two years. Tropical cyclonic conditions in the vicinity of Mauritius included only two tropical disturbances occurred in January 2011, three cyclones occurred between December 2011 and January 2012, and five cyclones, passing closer to Mauritius, occurred between October 2012 and January 2013. These findings indicate that increased frequency of tropical cyclonic conditions coinciding with the beginning of coral bleaching occurrence period mitigate thermal and irradiance stresses, and reduce bleaching effects on coral reefs.

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SOCIO-ECONOMIC IMPACTS OF EXPANDED HABITAT PROTECTION IN PULLEY RIDGE, FLORIDA GULF COAST (Abstract ID: 29666)

The Gulf of Mexico Fisheries Management Council designated Pulley Ridge as a HAPC in 2005. Although Pulley Ridge is in relatively intact ecological condition, its rarity and connectivity with the broader marine area lead agencies to believe that its protection is necessary. A small portion of the Pulley Ridge is banned for bottom trawling, but the agency is considering expanding its reach. The commercial fishers are extremely sensitive to new or additional management actions as some of them are still recovering from the Florida Keys sanctuary regulations of the 1990s. This paper is an attempt to understand how the additional HAPC designations may influence commercial fishers by analyzing their perceptions towards the new regulation, current harvests, and their economic connections with different coastal zones of the Florida Gulf coast. A survey of 50 commercial fishers is conducted. The secondary data on species-wise and vessel-wise catches, and their flow to various port destinations are analyzed. The economic impacts that the reductions in fish catch in the Pulley Ridge have on various economic sectors of the region are also analyzed using a regional input-output model. The results indicate that the HAPC expansion in Pulley Ridge will have some negative impacts on a couple of fishing destinations in the Florida Gulf coast. However, the real management challenge emanates from the negative experience the stakeholders suffered during the past regulations. Efforts toward educating them about the long-term benefits of the current HAPC is therefore essential.
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INFLUENCE OF TEMPERATURE VARIATION ON QUORUM SENSING SIGNAL PRODUCTION BY BLACK BAND DISEASE HETEROTROPHIC BACTERIA (Abstract ID: 29578)

Black band disease (BBD), one of the most aggressive and complex coral diseases, is comprised of four functional groups of bacteria (photoautotrophs, sulfide oxidizers, sulfate reducers and heterotrophs) causing disease progression. The heterotrophs have been shown to produce quorum sensing (QS) signal molecules, comprising of acyl homoserine lactones (AHLs) known to be involved in pathogenesis of numerous bacterial diseases worldwide. BBD infects corals when sea water temperature exceeds 28°C. Hence the primary goal of this research was to examine the effect of temperature on AHLs produced by heterotrophs from BBD to assess a potential role of QS in BBD pathogenesis. 156 bacterial isolates from BBD, 38 from surface mucopolysaccharide layer (SML) of healthy corals (HSML), and 36 from healthy SML of BBD infected corals (BSML) were tested for production of AHLs by a reporter strain bioassay. 24 QS positive heterotrophs were further exposed to varying temperatures (24°, 27°, 30° C) to determine the role of temperature on AHLs using LC-MS/MS. Out of eight AHLs that were discovered, 3OHC4 was the most abundant AHL (produced by 17 of 24 isolates), shadowed by C6 (13 out of 24 isolates). Statistical analysis showed a species specific AHL variation profile, and that 3OHC4, 3OHC5 and 3OHC6 were most significantly affected. Influence of temperature variation was more significant on a global level than on an individual species level for specific AHLs. 16S rRNA gene sequencing revealed that most of the QS positive isolates were vibrios. The results from this research will assist in decrypting the mechanism and etiology of one of the most destructive and intricate coral diseases.

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ARE WE APPROACHING A LIMIT OF RESILIENCE TO REPEAT BLEACHING OF CORAL COMMUNITIES IN MAYOTTE, SW INDIAN OCEAN? (Abstract ID: 29252)

The island of Mayotte is in the core of a high marine biodiversity center for the Indian Ocean, bathed by an intermittent gyre and dynamic meso-scale eddies that result in high variability of water conditions, but within a relatively narrow temperature band. High levels of coral bleaching on the island have been documented 3 times (1983, 1998 & 2010) and a fourth is imminent in 2016. The 2010 bleaching event was severe (SST at +0.59C), affecting 52% of corals, with a final mortality estimated at 32%. Bleaching was strongly zone-dependent, with the hottest regions in the north suffering significantly higher bleaching and mortality than cooler regions in the south. Acropora was the dominant genus, and dominated the bleaching response, followed by Pocillopora, Montipora and Porites. Bleaching and mortality were strongly size-dependent, with larger colonies more susceptible than smaller ones. The 2016 bleaching event is expected to be severe (SST predicted at +0.84C), though the absence of bleaching in 2014 and 2015, which were also record hot years equivalent to 1998, suggest some adaptation and acclimation has occurred. Data will be collected using the same methods as in 2010, using 25*1 m belt transects to record the condition of all hard corals (genus, size and degree of bleaching, mortality and disease). We will focus on genus, size and region influences on bleaching and mortality, and differences between the 2010 and 2016 events that may indicate adaptation to increasing temperatures or the increasingly frequent major bleaching events affecting Mayotte.

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FROM MONITORING TO COMMUNITY-BASED MANAGEMENT: RESULTS FROM THE 'OPIHI PARTNERSHIP (Abstract ID: 29886)

The 'Opihi Partnership, composed of community, academic, governmental and non-governmental organizations, was constructed under a paradigm where all stakeholders are equal. The stakeholder members seek to understand and ultimately see the replenishment of the highly sought after endemic limpets. There are several reasons for the success and longevity of the 'OP: incorporation of indigenous and western sciences, long-term commitments from partners, each partner benefits from membership, and yearly trips by members to Papahānaumokuākea Marine National Monument are but a few. The 'OP started with the modest goal of counting 'opihi. This effort spawned numerous outreach and educational events, a mountain of data, and ultimately, action. Due in part to their experiences in the 'OP, members have moved toward actively managing not only their 'opihi, but a plethora of marine resources. Here we present a summary of results and successes of the 'Opihi Partnership. We further describe how the 'OP model can be generalized to the reef ecosystem level.

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A FUNCTIONAL ANALYSIS OF ALGAL ASSEMBLAGES ON THE GREAT BARRIER REEF TO ESTIMATE EFFECTS ON CORAL COMMUNITY DYNAMICS. (Abstract ID: 28402)

We combine knowledge of macroalgal functional traits with abundance data from 960 surveys of macroalgae on the Great Barrier Reef in a novel approach to assess effects of macroalgal assemblages on coral community dynamics. Cluster analysis of the survey data identified 75 key macroalgal genera that contributed to 13 repeatedly observed macroalgal assemblages. For these 75 genera we estimated the strengths of 24 traits likely to influence corals. Traits were selected for relevance to: the potential for an

assemblage to establish; competitive impacts on corals; impacts on coral recruitment; potential to modify habitat; influence on stability of a macroalgal bloom. We combined the abundance of genera present in each assemblage with the trait dataset to estimate the effects of each macroalgal assemblage. Measures of functional diversity and community weighted mean were used to estimate the likely ecological effects of each of the 13 Great Barrier Reef macroalgal assemblages. In this way we combined data from field surveys with the predictive strength of trait analysis to estimate likely community trends. We suggest that benthic surveys which pay attention to localized macroalgal traits can provide insight to future community interactions, impacts to coral recruitment, trends in abundance of macroalgae and stability of macroalgal blooms, thus can provide valuable guidance to management decisions.

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RESPONSES OF TWO SCLERACTINIAN CORALS TO METAL POLLUTION AND OCEAN ACIDIFICATION (Abstract ID: 29880)

Metal pollution affects many reefs worldwide and while the effects of ocean acidification alone or in combination with warming on coral metabolism have been extensively investigated, none of these studies consider that corals might be already affected by other anthropogenic inputs, such as metal pollution. Here we tested in laboratory conditions the combined effect of ocean acidification and cobalt concentrations on two corals: *Stylophora pistillata* and *Acropora muricata*. Two pH levels (8.02 and 7.75) and two cobalt concentrations (natural, 0.03 µg $L^{-1}$ and polluted, 0.2 µg $L^{-1}$) were tested during five weeks in aquaria. For both species, cobalt input decreased significantly their growth rates by 28%, while it stimulated their photosystem II. By contrast, low pH did not affect their growth rates. The effect of higher cobalt concentrations (1.06±0.16 µg $L^{-1}$) on *A. muricata* was also measured *in situ* using benthic chamber experiments. At this concentration, cobalt decreased both coral growth and photosynthetic rates. Even if no interaction between pH and cobalt concentration have been revealed in our study, it is likely that coral colonies, for which growth rates decrease when submitted to a moderate cobalt input, will be weakened if they are subjected to additional threats (i.e temperature, other metal pollution). To confirm or cancel these conclusions, additional benthic chamber experiments have been performed on the same coral species to test the impacts of realistic nickel inputs.

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BOLSTERED PHYSICAL DEFENSES UNDER NUTRIENT ENRICHED CONDITIONS MAY FACILITATE A MACROALGAL SPECIES IN THE SOUTH PACIFIC (Abstract ID: 28962 | Poster ID: 280)

Human manipulations of top-down and bottom-up processes, through nutrient enrichment and overfishing, on coral reefs can cause a shift from dominance by corals to macroalgae. Turbinaria ornata, a brown macroalga, is rapidly expanding in range and habitat across the South Pacific, but the relative importance of nutrient input and herbivory pressure, or an interaction between the two, in controlling its accumulation is previously unknown. Therefore, we investigated the impact of nutrients and herbivory on Turbinaria ornata. We conducted: 1) a mesocosm experiment assessing relative nutrient limitation, 2) a field experiment comparing importance of nutrients (+/-) and herbivory (+/-) to biomass accumulation, and 3) an herbivory assay and toughness test comparing enriched and ambient thalli to assess changes to anti-herbivory defenses. We found no evidence of growth being nutrient limited in T. ornata; rather than stimulating growth, nutrient addition deterred herbivores. However, when physical structure was removed, enriched algae were preferred, with consumption rates 25-fold those of unenriched algae. Additionally, enriched thalli were tougher than ambient thalli, suggesting physical defenses were bolstered by nutrient enrichment. We found a unique interaction where nutrients inhibit herbivory and facilitate T. ornata biomass accumulation. This has important consequences to coral reefs, as nutrient enrichment may allow T. ornata to become more prevalent on reefs in areas where it was once controlled by herbivory, possibly at the expense of coral species.
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THE SEA ANEMONE *EXAIPTASIA* AS A MODEL FOR CORAL MICROBIOME STUDIES (Abstract ID: 27935)

A plethora of human diseases and much of human physiology have been elucidated by studies using animal models. So too knowledge of scleractinian corals, in particular the role of *Symbiodinium*, has been advanced by studies with the coral model *Exaiptasia*. Other models could include the close scleractinian relative the Corallimorpharia and scleractinian coral cell cultures. All models are symbioses between an animal and a dinoflagellate (*Symbiodinium*), but there are numerous distinguishing attributes which allow the researcher to select one model over the others. For example, *Exaiptasia* can occur in the aposymbiotic state which is appealing when attempting to reveal the role of *Symbiodinium* in coral phenotypes. *Exaiptasia* and Corallimorpharia have several traits in common like relative ease of lab culture, ability to obtain a large number of clonal polyps, demonstration of both sexual and asexual reproduction and formation of stable symbioses with a range of *Symbiodinium* species. However, there is much more information on the biology and ecology and prolific genomic and proteomic data on *Exaiptasia* compared to Corallimorpharia. Apart from assessments of coral bacterial pathogens, coral models have seldom been used in coral fungal, prokaryote or viral studies. To address this paucity, we have grown Great Barrier Reef sourced *Exaiptasia*for 12 months in the laboratory. We will report its identity, the *Symbiodinium*types it harbours and features of its prokaryotic microbiome.

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CORALME: A MODERN SYSTEM FOR TIME-EFFICIENT DETAILED ANNOTATION OF LARGE CORAL REEF IMAGE DATASETS IN AN OPERATIONAL SETTING (Abstract ID: 29697)

CoralMe is a collaborative open-source system dedicated to underwater coral reef image annotation, with an emphasis on interactive and time efficient segmentation and recognition techniques. The primary objective of the library is to connect ecological monitoring initiatives with cutting-edge computer vision techniques through a lightweight, extensible, interoperable and robust system. Our contribution is twofold. First, CoralMe offers a set of basic functionalities focused on automation that can be used in a number of way, such as providing an enhanced user experience to speed up the task of manual annotation, or to build a fully automated coral recognition model using existing data. Second, CoralMe's functionalities can be extended to support new algorithms with little effort, rendering technological advances made by the computer vision community readily available to marine ecology efforts. This is made possible by its architecture consisting in a MATLAB backend service easily extensible by computer vision researchers, as well as a front-end API that makes use of the standard JSON-RPC communication protocol to allow CoralMe's integration to any existing software. CoralMe bridges the gap between expert annotation and computer vision engineers, contributing to faster development of reliable and precise measurement of coral resilience.
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BRYODIVERSITY IN REEFAL ENVIRONMENTS - WHAT CAN WE EXPECT THE FUTURE TO HOLD? (Abstract ID: 28809)

The Phylum Bryozoa has been given inadequate attention in the tropical habitats, including the reefal zones. Any estimates of biodiversity for this phylum are quite inadequate at present, by comparison with the more spectacular groups. The reasons for this knowledge gap include: the lack of discrimination of similar forms using optical microscopy; the difficulty of field sampling of the most diverse habitats within the reef ecosystem and the poor geographic spread of detailed sampling campaigns. Historical studies which enthusiastically aggregated large synonymies have made biogeographic analysis practically impossible at present. It would be desirable to estimate the biodiversity for bryozoans from each of the regions of coral-reef habitats, and to include similar estimates for adjacent shelf and deeper-water environments. However, several drawbacks make current estimates premature. In particular, sampling by SCUBA of rubble-encrusting species has rarely been attempted. Important studies based upon major sampling programs have provided monographs; however the taxonomic work is in need of modern revision using scanning electron microscopic methods. Estimates of bryozoan diversity derived from extrapolation from detailed sampling at extremely few sites suggest that locations may be host to up to about 200 species. Wider regions possibly attain up to 500 species. Tropical reef environments world-wide potentially encompass 2000 to 4000 species, at least double what is known at present.
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WHEN MISMATCHES DON'T MATTER: THE EFFECTS OF DIVERGENT ECOLOGICAL AND ECONOMIC SCALES IN COASTAL FISHERIES. (Abstract ID: 28968)

Conservation management decisions are often implemented at the scale of human communities, rather than the scale of the most relevant ecological dynamics. Research frequently points out the loss in efficiency that results from such scale mismatches. However, the scale of management is influenced by social, economic and political constraints on management actors; by the higher implementation costs of spatially-variable management plans; and by the independent behaviour of actors. While it is clear that objectives can be better achieved if management and ecological scales are aligned, it is not clear whether such benefits are large enough to justify the costs of alignment, or how alignment can be achieved in multi-actor contexts. On Manus Island in Papua New Guinea, small customary tenure areas define the scale of harvest decisions, but the populations in each area are demographically connected by pelagic larval dispersal. Using genetic parentage analysis, we quantify the extent of this scale mismatch for the commercially valuable serranid P. areolatus. Game-theoretic analyses show that the scale and strength of dispersal should disincentivise sustainable harvesting behaviour, since dispersal allows individual communities to externalise the costs of overharvesting to adjacent communities. Despite these mismatched scales, communities in southern Manus have created a tribal network for management and negotiation, emphasising the importance of social capital in avoiding suboptimal outcomes or the need for top-down governance.

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INNOVATIONS AND ADVANCEMENTS OF FISHERY-INDEPENDENT, VISUAL MONITORING OF CORAL REEF FISHES FOR ECOSYSTEM-BASED MANAGEMENT (Abstract ID: 29612 | Poster ID: 578)

Reef management requires detecting population change and the effectiveness of management intervention at small and large spatial scales. Innovations in 36 yr advanced non-destructive, diver-based visual monitoring of Florida reef fishes to support ecosystem and length-based assessments. Shifting from an experimental design to a random stratified survey allowed expanded coverage to the entire Florida shallow water (<30m) reef track (1081 km2). Circular plots efficiently provided habitat data and species composition, abundance, size structure, and habitat distributions for ~275 observed exploited and non-exploited reef-associated fish species. Improved digital benthic maps facilitated defining habitat strata and quantification of georeferenced sample units and domains. NITROX SCUBA increased bottom time and GPS navigation ensured precise sample location. Sampling was optimized by a two-stage, stratification based on depth, habitat type, management zone, and region. Advances include standard habitat classification based on habitat patchiness and relief, optimization based on sample variance of 5 exploited fishes in 4 families, and use of mean exploited length for sustainability. Iterative analyses of past data refined stratifications and future sample allocation for increased efficiency and precision. Adopting a single standard method by multiple institutions allowed pooling of limited resources to achieve wide geographic coverage and ecosystem-level assessments of change within and outside MPAs, and influences of hurricane disturbance, fishery regulations, and invasive fish.

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UNDERSTANDING THE INDO-PACIFIC BIODIVERSITY GRADIENT THROUGH COMPARATIVE PHYLOGEOGRAPHY OF BRITTLESTARS (Abstract ID: 28314)

Understanding the mechanisms underlying biodiversity patterns is of crucial importance in evolutionary and conservation biology. Here, we analyzed 15 widespread Indo-Pacific brittlestar species using mitochondrial and nuclear sequences, and microsatellite markers, to investigate the origin and evolution of biodiversity in the Indo-Pacific coral reefs, with a focus on the effects of past climate changes on population demography and speciation dynamics. Using Bayesian dating, Bayesian skyline plots, tests of simultaneous divergence and expansion, and recent approaches of scenario testing, we revealed numerous cryptic speciation events, an evolutionary hotspot in the South western Indian Ocean, shared demographic responses to past events among species, and connectivity patterns across the distinct Indo-Pacific biogeographic provinces. These results helped pinpointing areas of evolutionary importance and past glacial refuges and overall, shed light on the effects of past climate fluctuations on these reef organisms' population dynamics.

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COMPARING MESOPHOTIC AND EUPHOTIC REEF FISH SIZE, FEEDING GUILD COMPOSITION, DIVERSITY AND ENDEMISM IN THE AU'AU CHANNEL, HAWAII. (Abstract ID: 27973)

Mesophotic reefs (30-150m) are understudied habitats. Little is known about the fish assemblages that occur at mesophotic depths and this dearth of information limits the ability to understand and manage potential resources. Mesophotic reef assemblages in the Au'au Channel between the islands of Maui and Lanai in the Hawaiian Islands were compared with neighboring euphotic reef fish assemblages surveyed during 2007-2011. Using three different survey methods for the mesophotic and one method for the euphotic, approximately 7,000 mesophotic and 800 euphotic fish individuals were identified and their standard length estimated. In general, mesophotic fish were greater in both body length (12.5 cm versus 7.0 cm) and mass (233 g versus 86 g). Fish in five of seven feeding guilds were larger on the mesophotic reef although planktivores were larger on euphotic reefs. Mesophotic fish assemblages had greater species richness (92 versus 66 species) and endemism, but euphotic fish assemblages were more diverse (Simpson's Index of Diversity: 0.93 versus 0.86).

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QUANTIFYING CHEMICAL CHANGES IN THE "HEARTBEAT" OF A CORAL REEF ON TETIAROA ATOLL, FRENCH POLYNESIA (Abstract ID: 29577 | Poster ID: 240)

Anthropogenic carbon emissions have increased the threat of ocean acidification in coral reef ecosystems and could translate to crippling losses in marine biodiversity and other coastal ecosystem services. The ability to decode the complex and dynamic biogeochemical signal of ocean acidification in reef environments will dramatically increase our ability to identify the early signs of reef dissolution and manage the impacts of ocean acidification in reef ecosystems. To capture the fine temporal changes in reef chemistry that result from increasing ocean acidification, we have created a reef observation network on Tetiaroa Atoll, French Polynesia. Limited human impacts on this location make it an ideal setting for investigations of acidification on a pristine and mature reef environment. Our experiments feature instruments that monitor seawater pH, dissolved oxygen, and salinity at 15-minute intervals. We also conducted a series of 24-hr to 48-hr experiments to capture hourly variability in reef alkalinity, dissolved inorganic carbon, and nutrients. Preliminary analyses reveal a reproducible daily pattern in which oxygen and pH diverge in the early evening, suggesting a pulse of reef dissolution during this time. This phenomenon implies that certain portions of the reef may be more susceptible to dissolution and degradation than others. We aim to continue quantitative decomposition of our rich biogeochemical dataset collected over the last two years. The ultimate aim is to quantify the rate of atoll growth or decline in the context of increasing ocean acidification.

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PHOTOCONVERTIBLE CORAL FLUORESCENT PROTEINS: AN ADAPTATION TO THE LIGHT CLIMATE AT MESOPHOTIC DEPTHS? (Abstract ID: 28591)

The high-level expression of green fluorescent protein (GFP)-like pigments in mesophotic corals suggests an important biological function for this protein group other than the photoprotective role assigned to their homologues in shallow water cnidarians. Photoconvertible fluorescent proteins (PCFPs), which undergo a green-to-red spectral shift upon ultraviolet (UV) irradiation, are commonly found in mesophotic and depth generalist species, thus providing an opportunity to investigate alternative functions. Due to rapid attenuation of UV by the water column it is unknown, however, whether photoconversion can occur throughout the depth range of PCFP-containing corals. To assess the feasibility of PCFPs as an adaptation to the mesophotic light field, we investigated the spectral dependence of photoconversion both*in vivo* and *in vitro*. Exposing live coral colonies to different light spectra in a mesocosm experiment showed that photoconversion depends entirely on the presence of near-UV wavelengths. Using field irradiance

data from the Red Sea, we showed that photoconversion of purified proteins can occur down to mesophotic depths and is thus feasible as a deep-water adaptation. These findings provide new insights into the biology and ecology of mesophotic corals, as well as the function and regulation of coral fluorescent proteins.

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VERTICAL CONNECTIVITY ON ATLANTIC AND PACIFIC REEFS: A GENOME-WIDE ASSESSMENT OF SIX DEPTH-GENERALIST CORAL SPECIES (Abstract ID: 29091)

Mesophotic coral ecosystems can act as important refuges against disturbances affecting shallow reefs. Consequently, they have been hypothesized to aid in shallow reef recovery by acting as a source of propagules. However, to date, this assumption of vertical connectivity has only been tested for three different scleractinian coral species. Here, we summarize the results of vertical connectivity assessments for six different depth-generalist coral species (*Agaricia fragilis, Agaricia lamarcki, Stephanocoenia intersepta, Acropora aculeus, Seriatopora hystrix* and*Pachyseris speciosa*) from various locations in the Western Atlantic (Bermuda, Bonaire, Curacao) and Indo-Pacific (Great Barrier Reef, Coral Sea, Papua New Guinea). Using a modified RAD-seq approach that comprehensively removes endosymbiont contamination, we characterized genome-wide variation (~20,000-150,000 SNPs) across ~1,500 individuals from paired shallow (10-15 m) and deep (40-60 m) populations sampled at different locations and/or regions. Brooding species all exhibited genome-wide differentiation by depth, indicative of varying degrees of adaptive divergence. In contrast, differentiation in broadcasting species was mostly observed across geographic regions and not by depth. These results establish the first broader pattern demonstrating a contrasting potential for vertical connectivity based on reproductive mode, and allow us to move towards a more generic characterization of connectivity between shallow and mesophotic coral reefs.
http://www.mesophotic.org

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HABITAT LOSS REDUCES THE ABUNDANCE AND SPECIES RICHNESS OF CORAL REEF FISH RECRUITS REGARDLESS OF HABITAT CONFIGURATION (Abstract ID: 29202)

Habitat loss is a spatially complex process that not only reduces the total amount of habitat available, but also changes the spatial configuration of the remaining habitat. This may involve substantial increases in the degree of fragmentation (i.e. subdivision) and isolation of habitat patches, however the influence of these configuration changes relative to those of habitat loss are unknown. In this study we measured the independent and interactive effects of habitat loss, fragmentation, and isolation on the abundance and species richness of coral reef fish recruits. Replicate experimental seascapes were constructed with either control or a 50% reduction in habitat cover and cross-factored with two levels of fragmentation (9 or 18 habitat patches) or isolation (3m or 15m spacing between patches). Recruitment was surveyed after three months and data was pooled across patches to provide a seascape-level estimate of effects on total fish abundance, species richness, and individual species. Habitat loss resulted in a 60% decline in total abundance and 25% decline in species richness, regardless of levels of fragmentation or isolation. Most species declined with the 50% reduction in habitat, but exhibited variable responses to changing habitat configuration. Overall, most species were unaffected by fragmentation but responded positively to increased isolation, though this positive effect was in some cases restricted to treatments with higher habitat cover. These findings emphasize prevention of habitat loss for reef fish conservation in a changing world.

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OUTCOMES AND LESSON'S LEARNED AFTER 14 YEARS OF COMMUNITY-BASED CO-MANAGEMENT INITIATIVES ON FIJI'S CORAL COAST. (Abstract ID: 29796)

Community-based resource management can be an effective approach for biodiversity conservation and replenishing depleted reef fish stocks, particularly on Pacific islands whose indigenous communities have significant control over their resources. The customary fishing rights owners in Fiji's Coral Coast district of Korolevu-i-wai began marine co-management activities with the Fiji Locally-Managed Marine Areas Network in 2002. In 2005, this effort was bolstered by the integration of a community-based supporting organization that has facilitated the implementation of a suite of research, capacity-building, and community-development programs. While no-take and fished control sites had >35% macroalgal cover and <10% coral cover in 2004, the no-take protection provided by the relatively-small (<1 km2) tabu areas established as part of the marine management plan was sufficient to remove macroalgal cover and promote coral community recovery in the tabu areas, but not in adjacent fished areas. By 2012, coral cover in tabu areas exceeded 50% and tabu areas had 500% more coral cover, 50% more coral species, 50% more food fish species, and 500% more food fish biomass than adjacent fished areas which now have >70% macroalgal cover. Simultaneously targeting community development priorities and economic needs strengthened support for resource management and conservation actions. Strong traditional governance and inclusion of a broad suite of stakeholders have been key factors for the success of community-based resource management initiatives.

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PATTERN AND PROCESS IN TROPICAL FISH EXPATRIATION POLEWARD FROM THE GREAT BARRIER REEF (Abstract ID: 27948)

I summarise patterns of recruitment and persistence of coral-reef fishes along the SE Austrian temperate coastline establishes over a 16-year monitoring period. Recruitment intensity in southern locations is weakly related to East Australian Current (EAC) strength, with temporal patterns differing among key families (Chaetodontidae, Pomacentridae, Acanthuridae) and among the over 100 species recorded to date. A key bottleneck to population establishment at higher latitudes is winter water temperature, and recruitment and establishment of these species is related to site wave exposure. Life history characteristics of species and families also are good predictors of high latitude recruitment. Expected changes to EAC strength and sea surface temperature along this coastline are linked to measured patterns in growth and pelagic dispersal to suggest changes in the dynamics of this process under climate change.

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THE SUNSCREEN SHEEN: AN ASSESSMENT OF THE PRESENCE AND QUANTITY OF ORGANIC UV-FILTERS IN THE WATERS OFF WAIKIKI BEACH (Abstract ID: 28928 | Poster ID: 464)

Organic UV filters are known endocrine disruptors that interfere with larval and embryonic development, reproduction and gender determination in marine invertebrates, fishes, rodents and humans. They find their way into the environment via plastic and personal care product waste. When humans enter the ocean after applying sunscreens with organic UV-filters as their active ingredient they eventually wash off, directly entering the marine environment. In 2015, the state of Hawai'i received over 4.8 million visitors, over 3.6 million spending time on O'ahu, home to the famous Waikiki Beach and many other beaches that experience high visitor frequency, most of whom use sunscreen products with organic UV-filters. Few studies have attempted to quantify the presence of organic UV-filters in the nearshore waters of O'ahu. The present study aims to detect and quantify the following organic UV-filters: avobenzone, homosalate, octocrylene and oxybenzone in an effort to understand their prevalence and persistence in Waikiki's nearshore waters. Water samples will be collected on and 60cm below the surface at various locations along Waikiki Beach every three hours from 0600-2400. Analytes will be extracted using reverse phase solid phase extraction and analyzed using triple quadrupole liquid chromatography/mass spectroscopy. By detecting these organic UV-filters, we hope to spread awareness of the possible effects these compounds might have on biological systems, specifically nearby coral reef communities that experience constant exposure due to high visitor frequency.

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DESIGN OF CLIMATE CHANGE ADAPTATION MEASURES FOR A CORAL LAGOON BEACH IN MAURITIUS (Abstract ID: 29263 | Poster ID: 449)

Mon Choisy in northwestern Mauritius is an economically important public beach enjoyed by locals and tourists. Chronic erosion has resulted in the loss of up to 20 m of beach width in 40 years and is likely to increase in coming years due to global sea level rise, severely impacting beach amenity and economic viability. In 2014, the Government of Mauritius and UNDP, supported by the Adaptation Fund, initiated a project to analyze the causes of erosion at Mon Choisy and provide rehabilitation options. A comprehensive technical assessment incorporating physical and biological surveys, instrumental data collection and calibrated numerical modeling suggest that the erosion is caused primarily by the interruption of sediment supply from existing coastal works and the degradation of coral and seagrass habitats due to anthropogenic and natural factors, resulting in increased wave energy penetration into the lagoon, sediment mobility

and decreased production of coralline sand. Remedial measures proposed include the removal of *Casuarina* trees, beach reprofiling and replanting with native sand binding and coastal forest species, sand nourishment, low crested breakwaters for wave energy dissipation, seagrass rehabilitation, and the designation of a Voluntary Marine Conservation Area. While these measures may reduce erosion and result in a more resilient beach, they do not address the underlying causes of the erosion, highlighting the need for funding agencies to consider longer term programs with broader reach in order to fully address the threats to coral lagoon beaches.

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POPULATION ECOLOGY OF THE RED SEA LIONFISH *PTERIOS MILES* IN ITS NATIVE RANGE (Abstract ID: 27952)

Research of the lionfish introduction into the western Atlantic and Caribbean seas has revealed this species to be the most successful marine fish invader ever documented. To better understand the potential ecological reasons for this unprecedented invasion, we studied various population parameters of *Pterois miles* in its native habitat by tagging 36 individuals among a fringing reef in Egypt in October 2014. Initial recapture success exceeded 60% of fish tagged, but gradually declined to 10% by November 2015. Mean juvenile growth rates ranged from 7.8 to 10.2mm per month in summer, while adults (TLmax 32cm) had relatively constant growth rates of about 4mm per month throughout the year. In August, several adults had ripe gonads indicating that reproduction was about to take place. Site fidelity was strong with 50–100% of fish being recaptured at the initial tagging site while the remaining fish were recaptured within a 60m radius. To identify potential biotic constraints in the Red Sea, juveniles (TL <10cm) were caught and released near potential predators. Stonefish, moray eels, and several groupers ignored lionfish. Other groupers exhibited aggressive behaviors and continuously attacked until lionfish swam upwards into the water column using the current to drift away. Actual predation was not observed, suggesting habitat competition plays an important role in lionfish distribution. These observations provide new insights into population ecology of lionfish in their natural habitats that can improve our understanding of the distributions of invasive populations.

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THE SCLERACTINIAN CORAL FAUNA OF MOOREA (FRENCH POLYNESIA) : STABILITY OVER TIME VERSUS ENVIRONMENTAL DISTURBANCES ? (Abstract ID: 28532)

An inventory of the scleractinian coral fauna in the reefs surrounding the island of Moorea (French Polynesia) was conducted in 1978 by Kühlmann and the results published by Chevalier & Kühlmann (1983). In order to provide a reference collection for the research on coral reef being presently conducted at the CRIOBE, a comprehensive sampling survey was carried out in 2012, around Moorea, including most sites visited 34 years earlier by Kühlmann. In the intervening period numerous changes have affected the reef environment. These include direct and indirect anthropic disturbances, most of them linked to a sharp increase in the resident and transient (tourist) population, resulting in a general anthropisation of the shoreline, including landfill and coral sand and rock extraction. Further, several significant natural disturbances have taken place during that period, such as episodes of severe Acanthaster infestations, recurrent bleaching events, cyclones and protracted episodes of abnormally low sea level. Yet the qualitative comparison of the results obtained 34 years apart indicates very little overall difference in scleractinian diversity. Indeed, except for two species not found in 2012 but whose presence has been ascertained on the nearby island of Tahiti, the species lists are almost identical. The only notable difference is recorded for the family Acroporidae, particularly the genus Acropora. Hypotheses as to the mechanisms underlying relative stability of the scleractinian fauna around Moorea are presented, and consequences for reef management are discussed.

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DENSITY DEPENDENT HABITAT SELECTION DICTATES DISTRIBUTION OF REEF FISH FOLLOWING HABITAT LOSS (Abstract ID: 28497)

Habitat loss governs the distribution of species on a coral reef by altering the availability of resources. While we know that complete loss of habitat has severe negative effects on reef fish communities, we know relatively little of how species respond to patchy disturbances. This is surprising given that many threats facing coral reefs have a species bias, and therefore result in a mosaic of dead and live corals. In this study we investigated how an ongoing outbreak of the crown-of-thorns seastar affected the distribution of a common reef fish, *Pomacentrus moluccensis*. We identified reefs with a range of coral damage and recorded densities of fish on plating *Acropora*colonies. We found that densities of *P. moluccensis* on live coral colonies were greater with increasing proportions of dead coral. In addition, we describe how fish start occupying dead coral when >50% of colonies on a reef were dead. We suggest that the loss of habitat causes crowding on remnant live coral until some fish are forced to choose less preferred dead colonies. We then conducted a choice experiment to investigate if density dependent habitat selection was the mechanism underlying this pattern. When presented with the choice of two colonies, fish were more likely to choose a near empty alternate colony when the other colony was severely crowded with conspecifics. This study is the first to demonstrate density dependent habitat selection during an ongoing disturbance event and adds to the growing body of work outlining how reef fish communities are affected by disturbances.

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EXAMINING THE WIDE BAND FREQUENCY RESPONSES OF COMMON REEF FISHES- COMPARISONS BETWEEN MODELS AND MEASUREMENTS (Abstract ID: 29418)

Many heavily exploited fishes are crucial to the ecosystem function of reefs. A central challenge to quantifying change in coral reefs and their ecosystem services is the acquisition of spatially and temporally appropriate data to examine patterns in diversity and abundance of coral reef fishes, and in particular exploited target species. Wideband acoustic technology offers a promising tool that might allow inference at relevant taxonomic and spatiotemporal scales. Using the boundary element method with high-resolution computed tomography data, we examine numerically modeled acoustic scattering responses (12-250 kHz) of dominant reef fishes across a range of orientations. The modeled wideband scattering responses are compared with in situ measurements of wideband scattering from reef fishes obtained using the Simrad EK80 echosounder. Preliminary analyses suggest that wideband scattering responses in this frequency range are sensitive to the fine-scale morphological variations among common reef fish species. Further analysis will give insight into the appropriate frequency domain to examine the efficacy for taxonomic resolution.
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QUANTIFYING PROJECT IMPACTS AND MITIGATION OFFSETS BY PARTITIONING ECOSYSTEM FUNCTIONS AND SERVICES (Abstract ID: 28998 | Poster ID: 688)

Federally permitted projects that result in significant and specific loss of resources important to the human or aquatic environment are required to mitigate for that loss. The difficulty of defining linkages between project activities and their effects often leads to a controversial accounting of ecosystem value. Particularly on large public projects, selection of the type and scale of mitigation is often negotiated as final permits are either granted or denied. A rubric is needed to fairly balance the environmental cost of development against the benefits of mitigation using a common currency. This two-fold problem requires a correct assessment of the environmental impacts of development and the appropriate design of mitigation to offset losses. The 2008 Compensatory Mitigation rule does not require compensation for the loss of specific resources, but rather for aquatic resource "types, functions and services". Here we propose a methodology that focuses upon defining ecosystem functions and services threatened by proposed projects, and selection of the mitigation type and quantity needed to maintain ecosystem balance. Using the framework from the Millennium Environmental Assessment (MEA, 2005), the impact site is parsed into 27 ecosystem categories divided between Regulating and Support Functions, and Provisioning and Cultural Services. Analysis of each category allows the actual likely project impacts to be standardized in common terms. Knowledge of the specific ecosystem functions and services impacted enables resource agencies to select mitigation options that match the values and quantities of ecosystem functions and services jeopardized by the proposed project.
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MICROBIAL METABOLIC SHIFTS DURING IN-SITU DEVELOPMENT OF CORAL BLACK BAND DISEASE (Abstract ID: 29044)

Black band disease (BBD) is a virulent, globally-distributed infectious disease characterised by a darkly pigmented polymicrobial band at the interface between apparently normal coral tissue and freshly exposed skeleton. Microbial taxonomic profiles for BBD

have been extensively characterised, but the underlying microbial metabolic functions that contribute to anoxic and sulphide-rich microenvironments within the lesion and govern its pathogenicity have not been documented. Combined metagenomic and metatranscriptomic profiling of microbial lesions at two stages in BBD development were sampled from replicate coral colonies: 1) a less-virulent precursor stage termed cyanobacterial patches, and 2) a fully developed BBD lesion. The development of BBD pathogenicity is linked to relative increases in production of sulfide within the lesion by sulfate-reducing bacteria, and to photosynthetic CO2-fixation by cyanobacteria. The latter play a pivotal role in pathogenesis by introducing organic carbon in addition to nutrients derived from dead coral tissue. Furthermore, heterotrophic bacterial degradation of organic carbon produced by cyanobacteria represents a key mechanism for the depletion of dissolved oxygen within BBD lesions to levels harmful to underlying coral tissue, especially in the absence of light. The increased mechanistic understanding of BBD development provided by this 'omic'-based study highlights the complexity of microbial interactions within the polymicrobial communities involved in the pathogenesis of BBD.

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LATITUDINAL VARIATION IN SPAWNING SYNCHRONY OF ACROPORA CORALS (Abstract ID: 28955)

Reproductive synchrony is a feature of many plant and animal populations. High reproductive synchrony between species of scleractinian corals is known to occur in a wide range of locations in the world. Levels of synchrony are, however, variable between locations. It has often been suggested that the synchrony is driven by environmental variables correlated with latitude, such as water temperature, insolation and photoperiod. We here develop a method to quantify spawning timing and synchrony, and apply it on a large dataset that compiles Indo-Pacific Acropora reproductive data from 152 reefs in 17 countries between the latitudes 35°S and 35°N. We then test the hypothesis that the spawning synchrony in Indo-Pacific Acropora species correlates with latitude. We found no correlation between synchrony and latitude, which further supports the hypothesis that synchronous spawning is a feature of all speciose assemblage. Although it is well-accepted that variables such as water temperatures and lunar cycles strongly influence the seasonality and timing of coral reproduction, the exact factors that determine the level of synchrony within and among populations remain to be identified, potentially involving factors other than environmental ones, such as socio-biological or ecological ones.

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EFFECTS OF OCEAN WARMING AND CO2-INDUCED ACIDIFICATION ON CALCIFICATION OF FOUR CARIBBEAN REEF-BUILDING CORALS (Abstract ID: 28700)

Rising atmospheric carbon dioxide (pCO2) has caused ocean temperature to increase and pH to decrease, raising concerns about the health of marine organisms. Corals are particularly vulnerable to these stressors, likely due to their narrow thermal tolerance and use of carbonate ions in calcification, although response patterns vary across taxa. We conducted controlled laboratory experiments for approximately 90 days to investigate the independent and interactive effects of ocean warming (28, 31 C) and acidification on the calcification rate and skeletal properties of four keystone Caribbean reef-building corals (*Pseudodiploria strigosa, Siderastrea siderea, Porites astreoides, Undaria tenuifolia*) collected from the Belize Mesoamerican Barrier Reef. Aragonite saturation states of 3.9, 3.2, 2.2, and 0.7 constrained by total alkalinity measured via closed-cell potentiometric titration and dissolved inorganic carbon measured via coulometry, were attained by sparging natural seawater with air-CO2 mixtures formulated at 280, 400, 700, and 2800 ppm pCO2, respectively. Temperature and pCO2 were fully crossed with three-fold treatment replication. Calcification rates for all species exhibited a generally decreasing trend with increasing pCO2, although this trend was not always linear. The negative effects of pCO2 were more pronounced at 28C than at 31C. Notably, three of the species exhibited net skeletal dissolution in the treatments that was undersaturated with respect to aragonite, with only *S. siderea* producing skeleton on a net basis under these conditions.

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ACROPORA CERVICORNIS TRANSPLANTS AS FISH HABITAT AND AS A POSITIVE INFUENCE TO FISH RECRUITMENT ON CARIBEAN REEFS (Abstract ID: 30139)

No-take MPAs have been established widely as a fisheries restoration measure and to reestablish the ecological balance essential to coral reef health over time. However, where Caribbean Acropora cervicornis corals have become locally extinct, they do not return on their own through larval recruitment processes. For such situations, staghorn Acropora transplantation may be required in order for the natural balance of the MPA to be obtained, resulting in restored fish and invertebrate populations by increasing vital branching coral habitat. From the perspective of evaluating coral transplantation as a potential coral reef and fisheries management tool, the specific impacts of coral transplantation on fish populations is of fundamental importance, particularly for reefs suffering from algal overgrowth or other ecological imbalance due to low fish numbers. If a lack of fish is related to a lack of habitat, Acropora transplantation could potentially be important in reestablishing fish populations that would then help reestablish a broader ecological balance and lead to conditions more conducive to recovery. Specific interactions between coral transplants and fish recruits are investigated in this study, focusing on the following questions: 1. what fish families, size, and numbers do coral transplants on rock, rubble, or sand, or seagrass substrates provide?, 2. does proximity to the reef (<3m, >30m) or substrata effect fish numbers, diversity, or initial recruitment size to coral transplants?, and 3. does the relative number of fish recruits influence coral health or growth? https://www.facebook.com/C4Conservation/

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REPLACING BARBIE'S NOTEBOOK: HOW DIGITAL TECHNOLOGY IS REVOLUTIONIZING DATA COLLECTION IN SMALL SCALE FISHERIES (Abstract ID: 30054)

The collection of fisheries data from small scale fisheries has historically been a challenge for national governments. The technical and financial investment required to sustain data collection across scores of communities whose fishers target complex multispecies fisheries, often with a low catch value has not been an obvious priority when allocating limited national budgets. In the last few years however the advent of low cost cloud computing and the widespread adoption of smart phones in rural areas means that the technology exists to revolutionize data collection and vastly improve the ability and cost effectiveness of collecting, analyzing and disseminating fisheries information at national scales. Here, I present case studies from both the Caribbean and South East Asia where a simple to use data collection system built around a mobile App, a solar powered vessel monitoring device and a digital registration system, have been deployed across large geographic areas to capture high resolution data on a range of small scale fisheries. I explore the challenges presented by moving record keeping from note books to the cloud, the need for careful design in technology to overcome barriers in literacy and language, and the development of data management pipelines and automated systems to collate, analyze, interpret and disseminate data in near real time. The approach is rapidly increasing our understanding of how fishers use the seascape and coral reef resources, empowering decision makers at all levels and enabling science to underpin small scale fisheries management.

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EVALUATING TRADE-OFFS BETWEEN FISHERIES HARVEST AND CORAL REEF RESILIENCE (Abstract ID: 29926)

Reef fisheries are required to take an ecosystem approach to their management, yet informing management with policies that avoid ecosystem impacts is challenging in highly complex systems, particularly if the target species serve an important ecosystem function. Caribbean coral reefs provide a classic example where herbivorous fish are an important fishery but depletion can elicit cascading impacts that lock reefs into degraded states. To date, scientists have recommended bans on parrotfish exploitation but this simply isn't politically or economically feasible in the majority of countries. A fisheries policy is needed that permits exploitation while limiting the impact on reef resilience. We modelled the impacts of a parrotfish fishery on the future state and resilience of Caribbean coral reefs, enabling us to quantify the trade-offs between harvest and ecosystem health. We find that implementation of a simple and enforceable size restriction of > 30 cm provides a win:win outcome in the short term, delivering both ecological and fisheries benefits leading to increased yield and greater coral recovery rate for a given harvest rate. However, maintaining resilient coral reefs even until 2030 requires the addition of harvest limitations (< 10% of virgin fishable biomass) to cope with a changing climate and induced coral disturbances, even in relatively healthy reefs today. Managing parrotfish fisheries is not a panacea for protecting coral reefs from climate change but it can play a role in sustaining the health of reefs and high quality habitat for reef fisheries. http://www.marinespatialecologylab.org/

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SOCIAL RESILIENCE AND THE BUSINESS CASE FOR INCREASING INVESTMENT IN WASTEWATER TREATMENT: THE IMPORTANCE OF INTEGRATING EFFECTS ON NATURAL CAPITAL (Abstract ID: 30019)

Natural capital is Earth's stock of natural assets, including land, air, water and living organisms. For many developing nations, the quantity and quality of key ecosystem services that flow from natural capital (e.g. drinking water, fisheries, and tourism) continue to decline due to the negative impact of wastewater pollution. It is becoming more broadly understood that the degradation of natural capital can have significant impacts on the long-term environmental and economic resilience of a community. Therefore, in an effort to strengthen support for investment in critically needed wastewater infrastructure, economic analyses are expanding to include both traditional elements (e.g. the cost of various wastewater treatment alternatives) and elements related to natural capital (e.g. the value of ecosystem services). However, coral reefs and other natural resources also have a quantifiable cultural value, and their degradation erodes cultural natural capital – a critical component of a community's social resilience. This is reflected in a global paradigm shift in international development priorities, with capital investment decisions resting increasingly on a more thorough assessment of project impacts that accounts for the link between social resiliency and a community's economic and environmental resilience. Our paper seeks to demonstrate that project stakeholders can leverage a business case approach to evaluating wastewater infrastructure projects with a focus on conserving existing, and creating new, natural capital.

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LOW BUT STABLE REEF SHARK POPULATION ABUNDANCE AND DENSITY AT AN UNFISHED CORAL REEF (Abstract ID: 28401)

Baseline population estimates are lacking for many marine species, especially large predators such as reef sharks. The grey reef shark (Carcharhinus amblyrhynchos), which is listed as Near Threatened on the IUCN Red List of Threatened Species, is highly mobile and therefore particularly difficult to monitor. We used spatial capture-recapture (SCR) models, which incorporate movement effects, to produce the first spatially explicit, baseline population abundance and density estimates of grey reef sharks at Palmyra atoll, a remote, unfished U.S. National Wildlife Refuge in the central Pacific Ocean. We estimated a mean density of 17-21 grey reef sharks/km2, which translates to a total population size of 6261-8344 sharks at Palmyra. Shark abundance was stable through the course of the eight-year study, and shark distribution was non-uniform giving rise to density hotspots. Our density estimate is at least an order of magnitude lower than previous estimates at Palmyra based on data from spatially limited underwater diver surveys. Pristine coral reef locations have been characterized as having 'inverted trophic pyramids', yet this concept may be based on potential overestimates of apex predators from visual surveys in these systems. In addition, the insights from this study suggest adjusting reef shark recovery targets, as present targets are likely unrealistic and therefore impossible to achieve. At the same time, harvest quotas warrant similar downgrading to prevent continued overexploitation of reef sharks.

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USING BIOCRITERIA AND THE BIOLOGICAL CONDITION GRADIENT TO PROTECT CORAL REEF ECOSYSTEMS (Abstract ID: 28688 | Poster ID: 616)

Biological assessments (surveying the presence, number, size and condition of fish, corals, algae, plants, and other biota) provide important information about the health and integrity of coral reef ecosystems. Biological criteria are a way of describing the qualities that must be present to support a desired condition in a waterbody and serve as the standard against which assessment results are compared. A Biological Condition Gradient (BCG) provides explicit characterization of how attributes of the biological system change as human disturbance increases, establishing clear and scientifically defensible narratives for different levels of biological condition. Comparing results of biological assessments with BCG thresholds is an effective approach for evaluating the integrity of coral reef ecosystems, weighing management options and communicating status and goals. Decision-makers can use the BCG to determine which level most appropriately describes the current condition of their reefs and what conditions are desired, and can set easily communicated, quantitative goals for achieving those conditions. A variety of coral reef management activities can be supported by combining biological assessment and a coral reef BCG: these include water quality standards and condition status (excellent, good, fair, poor), pollution management (point source and non-point source), dredge-and-fill permitting, risk assessment to aquatic life from hazardous waste sites, risks to threatened and endangered species, environmental impact assessment and fisheries.

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LARGE-SCALE, LONG-TERM INTERDISCIPLINARY ECOSYSTEM ASSESSMENT AND MONITORING OF THE U.S. PACIFIC ISLANDS TO SUPPORT ECOSYSTEM-BASED MANAGEMENT AND CONSERVATION (Abstract ID: 29028)

Effective ecosystem-based management and conservation of coral reefs requires information about what ecological resources are available, where those resources are located, how and why those resources are changing over time, how those resources are utilized and valued by people and communities, and how human activities, including climate change, are effecting the sustainability of the ecosystems. Since 2000, NOAA's Coral Reef Ecosystem Program, in partnership with Federal, State, and Territorial agencies and academic and non-governmental institutions, has been mapping, monitoring, and conducting applied research to provide these types of information to support sustainable management of the coral reef ecosystems of Hawaii, American Samoa, Guam, the Northern Mariana Islands, and the U.S. Pacific Remote Islands as the Pacific implementation of NOAA's National Coral Reef Monitoring Program. Triennial surveys at over 40 island ecosystems monitor the abundance, diversity, size, and condition of corals, other invertebrates, algae, fishes, and microbes, as well oceanographic and environmental conditions and human uses influencing them. Use of systematic and consistent methods across diverse gradients of biodiversity, oceanographic conditions, and human uses and impacts allows an unprecedented opportunity to perform comparative biogeographic and socio-ecological analyses. We will discuss how these analyses can inform efforts by fisheries and coastal resource managers to effectively implement ecosystem-based management to achieve a balance between ecological and human well-being.
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HERBIVOROUS GRAZING IN A NEW DIMENSION: THE IMPORTANCE OF MICRO-TOPOGRAPHIC COMPLEXITY (Abstract ID: 27994)

On coral reefs, the grazing pressure exerted by herbivorous fishes is a major determinant of benthic community structure. Using a trait-based experimental approach, we demonstrate that previous schemes of herbivore functional diversity are missing a key component of coral reef consumer-producer dynamics. Specifically, we show that micro-topographic refuges and the functional identity of herbivores that are able to exploit resources within

these refuges strongly affect benthic community development. Within refuges, benthic communities are grazed by a small suite of functionally similar species, which only crop the apical portion of algae. In contrast, surfaces outside of refuges are grazed by a wide range of species from various functional groups, including species that extract the entire epilithic algal matrix or its particulate component. This functional filtering results in two separate grazing regimes, which create distinct coexisting benthic assemblages: assemblages within refuges are diverse, supporting several types of algae as well as juvenile scleractinian corals, while communities outside refuges feature low diversity assemblages dominated by simple filamentous turfs. These results suggest that, although limited to the scale of a few centimeters, micro-topographic refuges mediate the biotic control of benthic community development by affecting grazer functional diversity. Given the importance of coral reef consumer-producer dynamics, these results provide valuable information for the management of herbivore functional diversity in a changing world.

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PRELIMINARY RESULTS FROM SENTINEL 2 MSI IMAGERY FOR CORAL REEF MAPPING APPLICATIONS (Abstract ID: 29460)

ESA's recently launched Sentinel 2 mission offers several desirable features for routine coral reef monitoring, including global coverage in coastal regions (20 km off the coast) with a 5-day revisit time, and 10 m resolution in visible wavelengths. In addition to providing data continuity to previous reef mapping from SPOT and Landsat missions, sensitivity analyses demonstrate that Sentinel 2 may provide more accurate mapping for coral reef applications. The ESA-funded Coral Reefs SEOM project (Scientific Exploitation of Operational Missions) aims to apply Sentinel 2 's capabilities to develop and validate coral reef composition and condition mapping and monitoring products. During the project, mapping and change detection of reef geomorphic zones and dominant benthic types, bathymetry and water column properties retrieval will be assessed over a range of different coral reef types. The algorithms developed in the SEOM project will be distributed as a set of open source software modules providing a validated processing chain for coral reef remote sensing. These tools will enable uptake of Sentinel 2 imagery for coral reef mapping and monitoring applications among the user community. With this presentation we aim to gather community feedback on the proposed monitoring products, present the study sites and discuss some preliminary results, including a comparison of physics-based bathymetry mapping between Sentinel 2, Landsat 8 and other imagery sources.

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DIVERSITY AFFECTS DISEASE TRANSMISSION IN CARIBBEAN CORALS (Abstract ID: 28769)

Coral disease can have devastating consequences for coral reef communities. There are several characterized diseases, including black band and white plague that affect multiple species of reef-building corals. In the Caribbean, species susceptibility to black band and white plague appears to vary among regions and outbreaks of disease are associated with different dominant species. Understanding how species susceptibility varies is important to predicting the future impacts of disease and may help to identify risk factors. This study tracked the prevalence of coral disease among multiple sites over an extended time period and examined the spatio-temporal patterns of species-susceptibility. Laboratory transmission experiments were completed to support whether field patterns indicated true variation in susceptibility or were solely a function of species density. Our results suggest that white plague and black band preferentially affect highly abundant orbicellids and *Siderastrea siderea*, respectively, but that this is a result of greater susceptibility and not just proportionally greater densities of the host species.
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DEEP ON THE CHEAP: ACCESSIBLE AND COST-EFFECTIVE METHODS FOR QUANTITATIVELY SURVEYING MESOPHOTIC CORAL REEF ECOSYSTEMS (Abstract ID: 29665 | Poster ID: 333)

An array of recent technological advancements has allowed broader scientific access to mesophotic coral ecosystems (MCEs). These reefs are now known to function in support of fisheries, serve as regional larval sources, and act as potential refuges for reef organisms. There is still a great deal unknown about these systems, including their global distribution. Although our collective understanding of MCEs has greatly increased in recent history, the costs of requisite technologies for accessing these environments—i.e., technical SCUBA, ROVs and AUVs—often hinders their study. We have developed a highly accessible and boat launched remote camera system that provides a rapid and cost effective approach to identify, quantitatively describe and monitor MCEs. We have undertaken three investigations using these techniques—on the north and south shelves of St. Thomas and within the Buck Island Reef National Monument, St. Croix, USVI. We have used this system to identify benthic structure of MCEs at depths between 30 and 100 m with and without high-resolution bathymetry. Equipment costs range from $500 to $3500 USD depending on desired depth and data requirements. We found that a crew of three people can sample 25 to 50 points daily depending on conditions and travel time. Post-processing of benthic photographs identifies coral species, macroalgae, sponge and cyanobacteria coverage. We discuss the broader applicability of these methods in remote regions and areas lacking high-resolution bathymetry and advanced SCUBA capabilities.

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MOVEMENTS OF THE REEF MANTA RAY (MANTA ALFREDI) IN THE RED SEA USING SATELLITE AND ACOUSTIC TELEMETRY (Abstract ID: 28019 | Poster ID: 519)

Populations of mobulid rays are declining globally. Understanding the movement ecology of these rays remains an important priority for devising appropriate conservation measures throughout the world's oceans. We sought to determine manta movements across several temporal and spatial scales with a focus on quantifying site fidelity and seasonality in the northern Farasan Banks, Red Sea. We fitted manta rays with acoustic transmitters and pop-up satellite archival transmitting (PSAT) tags, including four with GPS capability. All acoustically tagged individuals traveled frequently among high-use receiver locations and reefs and demonstrated fidelity to specific sites within the array. Estimated and realized satellite tag data indicated regional movements <200 km from the tagging location, largely coastal residency, and high surface occupation. GPS-tagged individuals regularly moved within the coastal reef matrix and showed fidelity to the high-occupancy sites identified by acoustic tagging. We also tested the accuracy of several geolocation models to determine the best way to analyze our light-based satellite tag data. We documented significant errors in light-based movement estimates that should be considered when interpreting this data. Despite some error in satellite tag positions, combining results from PSAT and acoustic tags in this study yielded a comprehensive representation of manta spatial ecology across several scales, and such approaches will inform the design of appropriate management strategies for manta rays in the Red Sea and tropical regions worldwide.

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CORAL PLASTICITY AND HOLOBIONT DYNAMICS UNDER THERMAL STRESS: INTRAPOPULATIONAL, INTERPOPULATIONAL AND INTERSPECIFIC VARIABILITY (Abstract ID: 29194)

In the context of global change, corals will be submitted to an increase of sea surface temperatures that will certainly reach values never experienced previously in their lifetime. In order to better predict the future of these animals of great ecological importance under this unusual thermal stress, we need to better understand the mechanisms

of coral's thermotolerance. In this work, we performed a comparative thermotolerance experiment for two coral species: *Pocillopora damicornis*, a tropical scleractinian coral, and *Corallium rubrum*, a temperate coral from the Mediterranean Sea. For each of these species we compared the response to thermal stress for individual genotypes of two populations which have experienced in their life history high or low annual thermal variations. As corals are metaorganisms, living in close association with complex microbial communities and/or symbiotic zooxanthellae (for *P. damicornis*), we followed the transcriptomic response of the cnidarian host (by RNAseq) and the dynamic of the associated microbiota (using 16S metabarcoding) at the upper limit of the thermotolerance of these different species / populations / colonies. These comparative analyzes of the thermal stress response of the coral holobiont have allowed us to identify potential similar molecular mechanisms existing between these two ecologically and phylogenetically distant species, as well as differences within the same species between populations experiencing different thermal regimes.

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SWELL AS A HIGH FREQUENCY DRIVER OF MACROALGAL COVER AND CORAL-MACROALGAL INTERACTIONS ON CARIBBEAN CORAL REEFS (Abstract ID: 30033)

Compromised Caribbean stony coral health due to tactile interactions with reef-associated macroalgae has long been observed. Elucidating primary physical and biological components driving local macroalgal benthic cover and coral-macroalgal tactile interactions requires high frequency, longitudinal data collection. We used a seven-year high frequency (monthly) data set of biophysical variables and macroalgal dynamics to determine the primary factors driving intra-annual changes in coral-macroalgal tactile interactions on 4 shallow (6-20 m) reefs in St. Thomas, US Virgin Islands. We found that both macroalgal benthic cover and prevalence of coral-macroalgal interactions were primarily negatively related to wave-driven turbulence, which likely forcibly dislodges macroalgae. Acute and chronic wave-driven decreases in macroalgal cover and coral-macroalgal interactions fit patterns related to location along the insular platform, depth, frond fragility, and relative attachment strength of dominant site-associated macroalgal species. Furthermore, any relationships between macroalgal cover/coral interactions and a suite of physical parameters including temperature, pH, sedimentation, turbidity, PAR, inorganic nutrients and chlorophyll were either minimal or influenced directly by wave turbulence. This study suggests that in coral reefs where macroalgae are major benthic components, macroalgal abundance and interactions with corals can be tied to water motion, providing another mechanism whereby moderate wave-driven turbulence might favor coral health and reef growth.

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ECOLOGICAL AND MORPHOLOGICAL TRAITS PREDICT DEPTH-GENERALIST FISHES ON CORAL REEFS (Abstract ID: 27776)

Ecological communities that utilise similar habitats may exhibit functional convergence despite significant geographic distances and taxonomic dissimilarity. On coral reefs, steep gradients in key environmental variables (e.g. light and wave energy) restrict some species to shallow depths. We show that depth-generalist reef fishes are correlated with two species-level traits: caudal fin aspect ratio and diet. Fishes with high aspect ratio (lunate) caudal fins produce weaker vortices in the water column while swimming, and we propose that 'silent swimming' reduces the likelihood of detection and provides an advantage on deeper reefs with lower light irradiance and water motion. Significant differences in depth preference among trophic guilds reflect variations in the availability of different food sources along a depth gradient. The significance of these two traits across three geographically and taxonomically distinct assemblages suggests that deep water habitats exert a strong environmental filter on coral reef fish assemblages.

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LIGHT MEDIATES THE PHOTOSYNTHETIC RESPONSE OF A CRUSTOSE CORALLINE ALGA TO OCEAN ACIDIFICATION, AND CONSEQUENCES FOR OTHER PHYSIOLOGICAL PROCESSES (Abstract ID: 29477)

Photophysiology has multiple potential avenues through which it could be affected by future ocean acidification (OA). Since photosynthesis influences energetic budgets as well as important physiological processes, including calcification and respiration, understanding how it is affected by OA is important for predicting the response of autotrophic taxa to OA. To determine whether light, through its influence on photosynthesis, could mediate the effect of OA on an important coral reef calcifier, experiments were conducted on a crustose coralline alga, Porolithon onkodes. In each experiment, two pCO2 levels (ambient and elevated) were crossed with three experimental light treatments. Calcification, respiration, net photosynthesis, and photochemical efficiency (Fv/Fm) were measured, and photosynthesis-irradiance curves were constructed. Interestingly, there was inhibitory effect of OA on some aspects of photophysiology in P. onkodes (photochemical efficiency), but neutral (maximum gross photosynthesis), and even facilitative effects on other aspects (light-use efficiency), and many of these effects were modulated by light. Additionally, unlike post-illumination respiration, dark-adapted respiration was two times higher under elevated pCO2. This indicates that photosynthesis may mitigate the stimulatory effect of OA on respiration. Finally, although light did not alter the negative effect of OA on calcification, the responses of photosynthesis and respiration could constrain the distribution of this species to a narrower range of light environments in the future under OA.

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INFORMING CATCHMENT MANAGEMENT PLANS TO IMPROVE COASTAL WATER QUALITY: AN APPLICATION OF NUMERICAL MODELS AND OBSERVING SYSTEMS IN THE GREAT BARRIER REEF (Abstract ID: 28638 | Poster ID: 533)

Declining water quality on the Great Barrier Reef (GBR) has been linked to a long-term decline of coral cover within the GBR World Heritage area. GBR reefs are naturally exposed to river runoff carrying nutrient and suspended sediment loads, but historical and current land-use practices have enhanced the delivery of terrestrially derived material in to the marine environment. Regional water quality improvement plans are a primary mechanism to manage and improve riverine coastal water quality, through actions in the source catchments targeted at reducing sediment and nutrient delivery into streams, rivers and ultimately the marine receiving waters. Hydrodynamic and biogeochemical models currently being applied to the GBR as part of the eReefs project provide a valuable tool for identifying, quantifying and communicating the spatial impact of discharges from various rivers into the GBR lagoon. Using hindcast simulations of historic wet seasons, river-tagged passive tracers were released from major rivers discharging into the GBR to provide a quantitative identification of high or extended exposure of spatial regions to river plumes. Simulated river exposures were coupled with estimated river nutrient loads to inform a spatial risk analysis of reef exposure to terrestrially derived pollutants. This modelling provided a quantitative basis for prioritizing catchments for management attention, and has informed the refinement of regional water quality improvement plans. http://aims.gov.au

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DIVERSITY AND ABUNDANCE OF DECAPOD MACROCRUSTACEANS IN REEFS DIFFERING IN STRUCTURAL COMPLEXITY AND SUBSTRATE TYPES (Abstract ID: 28795 | Poster ID: 293)

Decapod crustaceans are a major component of biodiversity and food webs in tropical coral reefs, but most depend on structured shelter for survival. Therefore, reef decapods might be affected by the ongoing loss of architectural complexity of Caribbean reefs. We analyzed diversity and abundance of decapods in two reefs (Limones and Bonanza) in Puerto Morelos (Mexico). Both reefs were similar in length, distance from the coast, and depth range, but Limones was more structurally complex due to greater acroporid growth, mailny over the crest zone. However, due to sampling constraints, our study was limited to the back-reef zone. Using transects, we assessed structural complexity in this zone using the rugosity index and HAS (habitat assessment score), estimated habitat types cover using AGRRA protocols, and quantified all visible decapods. Although structural complexity at the back-reef zone did not differ significantly between reefs, diversity

and abundance of decapods were higher in Bonanza, which exhibited a greater variety of substrate types. Three of the most abundant decapods occurred in close association with certain substrates, e.g., Calcinus tibicen (Anomura) with Millepora complanata, Domecia acanthophora (Brachyura) with Acropora palmata, and Mithraculus coryphe (Brachyura) with rubble. Our results provide a baseline for future comparisons and suggest that, in coral reefs, local diversity and abundance of decapods are modulated by the diversity of substrate types coupled with structural complexity and the establishment of commensal and other types of association.

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DYNAMICAL MODELING OF COUPLED SOCIETAL-CORAL REEF SYSTEMS (Abstract ID: 29889)

Societal-coral reef relationships are often rooted in ecological context, historical legacies, coastal heritage, and place-based socio-cultural traditions. These relationships have a nonlinear, dissipative character across spatio-temporal scales that render the coupled whole a complex dynamical system. Complex systems can exhibit feedback loops, preferred configurations (attractors), threshold-induced transitions (bifurcations), self-organization, emergence and other rich behaviors. As a complement to discipline-focused approaches, we take an initial step towards gaining insight into the societal-coral reef complex system by combining a dynamically based modeling approach with a set of complexity-based tools for analyzing model results. Coral reefs are simulated with a continuum partial differential equation model that has been upscaled from a spatially explicit cellular model. Modeled coral reefs are linked, via a fish population model, to fishing societies represented by agent-based models. Societal decision-making occurs either with utility functions that couple local fishing to a global fish market or with a heuristic decision-tree (transcending delineation of resources by value) in a traditional subsistence fishery. System behavior is characterized by emergent dynamics, attractors and bifurcations, and also by using nonlinear spatio-temporal forecasting to probe phase space. The dynamical contrast between a subsistence and a market-based fishery will be presented, and implications for management will be discussed.

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WILL WE MANAGE TERRESTRIAL POLLUTANT RUNOFF SUFFICIENTLY TO SAVE THE GREAT BARRIER REEF IN THE FACE OF CLIMATE CHANGE. (Abstract ID: 28036)

The Great Barrier Reef is in severe decline with coral cover down 75% since the 1960s and seagrass in decline. Causes of the decline are catchment pollutant runoff, climate change and fishing. Under current management the decline continues. In response to a UNESCO request to the Australian Government to show how the government planned to address the dire situation the 2050 Long Term Sustainability Plan (LTSP) was produced. The Plan is widely criticized by scientific and conservation groups as completely inadequate for its purpose. A major component of the Plan is action to manage water quality by better management of agriculture (beef grazing & cropping). Pollutant load targets are set – a reduction of 50% in fine suspended sediment loads and 80% in nitrogen loads in priority areas by 2025. A reliable estimate of funding required to implement management practices sufficient to achieve the targets is a minimum of A$780 million over the decade. This funding is unlikely to be available from Australian and Queensland Government sources. It is also unclear whether the improved management options currently available will be sufficiently effective in reducing loads by the required amounts. In the current situation it is highly unlikely the targets will be met by 2025 and "sufficient" resilience provided to Reef ecosystems to prevent further declines in the face of increasing climate change impacts. Our hope is for large increases in funding in the near future and rapid, widespread farmer uptake of innovative practices which sharply reduce sediment and nutrient losses from farms.
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CORAL REEF FISHES USE MANGROVE-DERIVED CHEMICAL CUES TO DIFFERENTIATE SETTLEMENT HABITATS (Abstract ID: 29254)

While coral reef fishes are known to use chemical cues derived from terrestrial vegetation to locate settlement habitats, whether these cues originate from the vegetation itself or rather from associated microbial communities has not been determined. Mangroves are a ubiquitous component of tropical coastal ecosystems, with stands frequently growing adjacent to coral reefs. As mangrove leaf fall often peaks during periods of high fish recruitment, cues from these leaves may represent an important source of settlement cues. In flume trials, both Indo-Pacific (Fiji) and Caribbean (Belize) reef fishes exhibited the ability to distinguish the odor of leaves from healthy versus polluted reefs. The strongest preferences were shown for fallen, submerged leaves suggesting a microbial influence. The results of a patch reef study indicated that reef-associated mangrove leaves can directly affect levels of recruitment. Recruitment was highest on patch reefs paired with the odor of healthy-reef mangrove leaves and lowest when paired with the odor of polluted-reef mangrove leaves. However, when microbial communities were artificially removed from these leaves any difference in recruitment was not seen. These results suggest that reef-associated vegetation, and specifically the microbial communities associated with plant material, can provide recruiting fishes with an important source of information regarding both the location and health of nearby settlement habitats.

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RECOVERY TRAJECTORIES OF REEF FISHES FOLLOWING LARGE-SCALE DISTURBANCES SUGGESTS A HIGH DEGREE OF RESILIENCY AND IMPORTANCE OF HABITAT AVAILABILITY AND QUALITY (Abstract ID: 30072)

Many significant impacts threatening coral reefs worldwide occur at the landscape scale and result in long-lasting changes to live coral cover and reef architecture. While short-term monitoring efforts have proved useful at documenting the immediate changes that occur following such a disturbance, longer-term studies often are required to disentangle the independent and combined effects of the loss of live coral and reduction in habitat complexity on reef-associated communities. The reefs surrounding the island of Moorea recently experienced two large disturbance events, an outbreak of the crown-of-thorns seastar and large waves associated with a cyclone, which significantly reduced the cover of live coral and reef topographic complexity at an island-scale. In the 2-3 years immediately following these events, total abundance of reef associated fishes declined, overall fish biomass increased and species richness remained virtually unchanged. These results were due primarily to the substitution of very abundant, small-bodied, coral dependent species by larger bodied species of mobile herbivores. Recent data indicates that as live coral cover has increased, the species composition of the associated fish community has begun to return to its pre-disturbance state suggesting a high degree of resiliency. Recovery of populations of coral dependent species has occurred in an ordered manner related to the increasing size of newly recruited corals indicating that habitat availability and quality play a key role in structuring communities of reef associated fishes.
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VERMETID GASTROPODS AND ALGAE REDUCE CORAL GROWTH VIA CHANGES IN THE PHYSIO-CHEMICAL ENVIRONMENT AND MICROBIOME (Abstract ID: 28190)

Interaction modifiers alter the intensity of pair-wise interactions between other species. On coral reefs, macroalgae interact with corals, and the strength of this interaction can influence shifts from coral-dominated to algal-dominated communities. Other organisms can potentially modify the effects of algae on corals. For example, the nets of the sessile vermetid snail,*Ceraesignum maximum*, decrease coral growth and survival. These nets also may exacerbate the environmental conditions that lead to deleterious effects of macroalgae on corals. Using a combination of field and lab studies, we tested if (and to what extent) *C. maximum* modifies the effects of algae on coral growth by changing environmental conditions and altering the coral microbiome. Growth of corals (as measured by linear extension and calcification) declined in response to the combined effects of algae and vermetids. Vermetid nets reduced flow and led to changes in the oxygen microenvironment, even in the presence of high water flow. Potentially fueled by retention of microbial substrate (e.g., DOC) under nets, bacterial diversity and the relative abundance of Vibrios increased in the presence of vermetid nets. These results indicate that vermetids exacerbate the effects of algae on coral growth potentially via changes in physio-chemical conditions and microbial communities. Thus the presence of *C. maximum*has the potential to degrade reefs. However, in 2015, there was a recent mass die-off of *C. maximum* in French Polynesia. This die-off may lead to healthier corals and promote reef recovery.

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TRACING THE IMPACTS OF LAND-USE CHANGE TO CORAL REEF FISHERIES (Abstract ID: 29108)

Coral reef fisheries are important for the livelihoods of millions of people, yet are threatened by both overfishing and land-based inputs of nutrients and sediment. Integrated coastal planning requires linking land-uses to their impacts on fisheries, but quantifying these linkages is hindered by the diffuse and displaced impacts of land-uses on fisheries. We quantify the impacts of land-use change to a coral reef fishery in Fiji. Using statistical models that link land-cover maps, river run-off, reef habitat and fish biomass, we are able to link land-use change in catchments to resultant impacts on reef fisheries. The models indicate that stricter fishery management could improve fish biomass, but is critically constrained by poor water quality on numerous of reefs. Catchment management in several critical areas could improve fish biomass. Maps that quantitatively link land-uses in catchments to the productivity of fisheries offer a powerful tool to inform coastal planning.
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OCEAN ACIDIFICATION HAS NO EFFECT ON CORAL BLEACHING OR RECOVERY FOR SCLERACTINIAN CORALS (Abstract ID: 28729)

While effects of OA on hermatypic coral calcification are species-specific, the effects of OA on Symbiodinium photosynthesis are equivocal. Through the measurement of growth (calcification) and changes in photophysiological parameters (production, absorption) of the 2 scleractinian corals O. faveolata and P. astreoides, that were exposed to combinations of elevated pCO2 and temperature, the present study aims to establish an energetic model capable of quantifying future hermatypic coral calcification rates using autotrophic energetic inputs as predictors. Neither photosynthetic production or absorbance properties for O. faveolata was affected by pCO2 or temperature. P. astreoides also showed no effect of pCO2 on photosynthetic production or absorbance properties, but at high temperature (31.0 C), a significant reduction of 77% was seen for photosynthetic production and a reduction of 63% in absorbance properties. To further quantify the effect of OA on photophysiological function, P. astreoides that "bleached" at high temperature were allocated to ambient and high pCO2 treatments, at ambient temperature (27.0 C), where they were allowed to recover. Photosynthetic production recovered to ambient levels in 4 weeks, with no difference in recovery rates between ambient or high pCO2 treatments. Our goal was to increase the understanding of metabolic costs of OA and create a predictive model for future tropical reef systems, in an attempt to further our understanding on the effects of global climate change, as well as aiding in the management of current emission scenarios.

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INFORMING CORAL REEF MANAGEMENT DECISIONS AT FOUR U.S. NATIONAL PARKS IN THE PACIFIC USING DATA FROM A COMPREHENSIVE, LONG-TERM MONITORING PROGRAM (Abstract ID: 29639 | Poster ID: 625)

Effective management of coral reefs is challenging with local and global stressors. Robust monitoring data are critical to reef management. In 2006, the Pacific Island Network Inventory and Monitoring program of the U.S. National Park Service implemented monitoring protocols at four national parks in Hawai'i (Kaloko-Honokōhau National Historical Park [KAHO], Kalaupapa National Historical Park [KALA]), Guam (War in the Pacific National Historical Park [WAPA]), and American Samoa (National Park of American Samoa [NPSA]). Benthic marine community, marine fish assemblage, and land-based surface and groundwater quality protocols used a split panel sampling design to collect data on ecosystem "vital signs" and processes at replicate sites per park. Vital signs include coral species richness, percent coverage of benthic substrate types, fish abundance, fish biomass, and water quality variables. The value of these data is highlighted in three case studies that describe how the monitoring data have been used to manage an array of issues at the parks. First, reef areas at NPSA and WAPA vulnerable to Acanthaster planci outbreaks were identified to determine whether, and where, to focus culling efforts. Second, data were used at KALA to delineate zones with high fish biomass that were sensitive to fishing activities and warranted increased management. Third, surface water quality and groundwater data at KAHO were used to take management action that mitigated land-based threats to coral reefs. Comprehensive monitoring enables informed decision-making for resources.

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OVER A DECADE OF CHANGE IN SPATIAL AND TEMPORAL DYNAMICS IN HAWAIIAN CORAL REEF COMMUNITIES (Abstract ID: 29021 | Poster ID: 713)

The Hawai'i Coral Reef Assessment and Monitoring Program (CRAMP) was established in 1999 to describe spatial and temporal variation in Hawaiian coral reef communities in relation to natural and anthropogenic factors. In this study, we analyzed changes over a 17-yr period (1999 to 2015) based on data from 64 permanent reef stations at 32 sites in the main Hawaiian Islands. Overall mean statewide coral cover, richness, and diversity did not vary significantly since the initial surveys, although local variations in coral cover trends were detected. The greatest proportion of stations with significant declines in coral cover was found on the island of Maui (0.4), while Hawai'i Island had the highest proportion of stations with significant increases (0.67). Shallow (<5 m) stations experienced the majority of significant increases and decreases. Trends in coral cover at some stations varied over time due to acute (e.g., crown of thorns outbreak) and chronic (e.g., sedimentation) disturbances. Stations with increasing coral cover with the potential for recovery from disturbances were identified for possible management actions in the face of future climate change. Increasing water temperature in 2014 and 2015 has resulted in major coral bleaching events with associated mortality. Temperature models predict severe bleaching events to increase in frequency and intensity in coming decades with concomitant decline in Hawaiian corals. Trends reported in this study provide a baseline that can later be used to test this predicted decline associated with future warming.

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THE FUTURE OF COMPETITIVE CORAL REEF DYNAMICS: EFFECTS OF ELEVATED TEMPERATURES AND OCEAN ACIDIFICATION ON THE PHYSIOLOGY OF ACROPORA-HALIMEDA INTERACTIONS (Abstract ID: 29075 | Poster ID: 278)

Competition for limiting resources, specifically between coral and macroalgae, is critical in determining the structure and function of coral reef ecosystems. Global changes arising from greenhouse gases, notably the speed and scale at which these changes are occurring, are pushing coral reefs into conditions they may not have experienced in the past 420,000 years. These stresses have begun altering ecosystem dynamics, often favouring the superior competitor with deleterious effects to the functions and services of these systems. Here, coral-algal competition was examined temporally via an orthogonal design that investigated the effects of anticipated RCP8.5 seawater temperatures and/or ocean acidification on the calcification, production, and tissue properties of the staghorn coral Acropora and the calcifying macroalgae Halimeda. Seasonal field monitoring revealed Acropora-Halimeda interactions were one of the most abundant coral-algal interactions on the southern Great Barrier Reef, where Halimeda is commonly observed growing at the bases or among the branches of Acropora. In winter, RCP8.5 projected warming quadrupled Halimeda calcification, but only in the absence of RCP8.5 acidification, highlighting the adverse effects of multiple stressors. Remarkably, there were no significant harmful effects on the calcification of either organism due to their physical interaction in winter, suggesting that coral-algal relationships are more complicated than the believed dominance of macroalgae, and may in this case, be a commensal or mutualistic interaction.

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HOW DO THEY DO IT? AN EXPLORATION OF THE MOLECULAR UNDERPINNINGS OF IMMUNE PRIMING IN THE SEA ANEMONE*EXAIPTASIA PALLIDA*. (Abstract ID: 29531)

Coral disease outbreaks have been rapidly increasing on reefs worldwide, and our understanding of how corals respond to disease-causing agents remains limited. Our recent work has shown that the anemone *Exaiptasia pallida* possesses a transient form of immune priming lasting for up to one month. In this phenomena, a sublethal exposure to the coral pathogen *Vibrio coralliilyticus* protects the anemone from subsequent encounters, in comparison to naïve hosts. In the present study, we aimed to identify genes involved in the immunological priming response. Four weeks post-priming, both

primed and unprimed animals were exposed to a bacterial challenge, whereas a control group was not inoculated with bacteria. Primed and unprimed hosts were sacrificed for RNA extraction just prior to bacterial challenge, and again four hours following bacterial challenge in both primed and unprimed hosts, as well as with untreated controls animals. RNAseq analysis was conducted to a depth of 10 million reads per biological replicate (n=3). The analysis revealed a gene expression response associated with immune priming. We discovered 11 differentially expressed genes (FDR corrected p≤ 0.05) between primed and non-primed treatments. The molecular response associated with immune priming indicates varied changes in cellular regulation involving biological processes including immune effector processes, defense response to pathogen, and regulation of apoptotic processes. We propose a model to explain the molecular mechanism mediating immune memory in this early-diverging metazoan.

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AN OUNCE OF PREVENTION: BUILDING RAPID RESPONSE CAPACITY TO MINIMIZE IMPACTS OF ACUTE REEF IMPACTS ON GUAM (Abstract ID: 29119)

Early response to acute coral reef impacts such as coral bleaching and disease, crown-of-thorns starfish outbreaks, and vessel groundings, can prevent further impacts, facilitate restoration, and provide valuable information to improve long term outcomes. As these events are often unexpected, managers should build partnerships and capacity before an acute event occurs. This is especially important for managers on small islands as local capacity is limited and support may be days or weeks away. Coral reef managers and scientists on Guam have developed a Reef Response Team composed of government agencies and the University of Guam. The team collaborates with a regional network of coral reef managers and receives funding, training, and technical assistance from federal agencies. The team also relies on community reporting as an early warning system. Rapid response to acute impacts allows managers to document impacts, evaluate potential management interventions, and gain valuable lessons or information from the event. Early response to recent ship groundings allowed managers to minimize impacts to sensitive coral reef habitats and sea turtle nesting beaches and lessons learned are now being applied to contingency planning for spill and grounding response. The team also responded to the 2013 coral bleaching event in Guam and assessments and follow-up monitoring will inform reef management strategies. Case studies from Guam, response challenges facing small islands, and recommendations for improving response capacity will be discussed.

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CITIZEN SCIENCE TO IMPROVE COMMUNITY ENGAGEMENT: CONSIDERATIONS, CHALLENGES, AND RECOMMENDATIONS FROM THE GUAM COMMUNITY CORAL REEF MONITORING PROGRAM (Abstract ID: 28951 | Poster ID: 731)

The Guam Community Coral Reef Monitoring Program (GCCRMP) works with community members to collect data on reef health and improve community engagement in management. Led by NOAA staff in Guam, the program works with numerous partners, including government, education, and community organizations, to address local management priorities. Over 1,200 residents have participated in the GCCRMP and the program has grown from a simple citizen science project to a more comprehensive science based community conservation program. It began in 2012 with benthic habitat and macroinvertebrate monitoring, but has since diversified to attract new members and sustain member involvement. The GCCRMP now also includes socioeconomic monitoring, stewardship opportunities, and reef impact reporting. In addition, GCCRMP has established strong partnerships with the educational community through service learning and student internship opportunities. Members have investigated the benefits of marine preserves on macroinvertebrates and helped document coral bleaching in 2013 and 2014. The GCCRMP has demonstrated that citizen science can be a powerful tool to improve community engagement and support coral reef conservation efforts. It has also shown the importance of setting reasonable objectives, developing simple methods that can provide reliable data, building partnerships, and communicating effectively. This presentation will describe the evolution of the GCCRMP including successes, challenges, and recommendations for others seeking to establish citizen science and community engagement programs.

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POSITIVE MPA EFFECTS AFTER 8 YEARS OF CONSERVATION EFFORT AT REUNION ISLAND (INDIAN OCEAN) (Abstract ID: 29380)

Coral reefs at Reunion Island fringe less than 10% of the coastline and are a focal point for traditional fisheries, recreation and tourism. The increasing demand on the services they provide has led to conflict among users and societal debate. Their degradation, documented since the 1970s, is mainly due to land-derived pollution and overexploitation. To reduce direct human impacts, the Réunion Natural Marine Reserve (RNMR) was created in 2007. It comprises 3 protection levels: general protection zones open to traditional and recreational fishing (45% of surface area), no-fishing zones (49%), and restricted-access sanctuaries (6%). The effectiveness of this marine protected area (MPA) was assessed following a classic BACI design, comparing data from a baseline study prior to its establishment to data collected after 8 years of reinforced protection. Positive MPA effects existed within sanctuary zones on fore reef slopes, showing increases in total fish biomass (+67%), fishable biomass (+78%), biomass of families targeted by traditional fisheries (+900%) and a slight rise in fish diversity (NS). Here, coral cover remained stable or increased, while a general decrease in coral cover and diversity occurred on reef slopes outside sanctuaries along with a strong increase in algal turfs on all monitoring sites. The MPA produces significant biological responses respective of protection levels and the positive outcomes may contribute to a wider acceptance of the necessary constraints of an MPA among local users and representatives.

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DIRECT VISUALIZATION OF MOTILE BACTERIAL PATHOGENS TARGETING THEIR CORAL HOST (Abstract ID: 29744)

The infection of corals by pathogenic bacteria is an important contributor to the worldwide demise of coral reefs. These bacteria are always motile, yet the mechanisms by which they migrate towards the coral and land on the surface remain unclear. Dense carpets of epidermal cilia allow corals to generate strong vortical flows, which in addition to enhancing nutrient and oxygen exchange, represent a hostile hydrodynamic environment for motile bacteria and hinder their pursuit of chemical cues emanating from the coral. Using high-speed imaging coupled with dual-wavelength epifluorescent microscopy, we tracked individual cells of the coral pathogen Vibrio coralliilyticus in the immediate vicinity of a scleractinian host, Pocillopora damicornis. We simultaneously determined the bacterial trajectories and the fluid flow produced by the coral's cilia with micrometer precision. This allowed us to directly quantify the ability of the bacteria to target and ultimately reach the coral surface. We find that the strong ciliary flows significantly, but not entirely, impede bacterial navigation towards the coral surface due to (i) the disruption of chemical gradients guiding the bacteria, and (ii) the hindrance of directed swimming by hydrodynamic forces produced by the ciliary flows. Direct visualization of bacteria swimming in the vicinity of the coral host and making initial contact with the coral surface is a powerful approach to shed light on these important precursor steps to infection.
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SYMBIONT COMPOSITION AND DENSITY CHANGE WITHIN TWO MURICEA SPECIES OF THE FLORIDA KEYS ACROSS A BLEACHING EVENT (Abstract ID: 28987 | Poster ID: 354)

Coral bleaching (the loss of the algal symbionts) due to increased sea surface temperatures has led to increased mortality of many scleractinians. However, bleaching among octocorals is less common. We monitored Symbiodinium type and densities in two octocorals within the genus Muricea across the Florida Keys 2015 bleaching event. Muricea elongata colonies were tagged and sampled in May, September and November 2015, and colonies of Muricea atlantica were sampled in September and November. Cell densities and symbiont type were determined for each species. Cell densities were significantly different from month to month, with the lowest densities occurring in September, establishing that both species did indeed bleach. Based on cell counts, as well as visual observations, September Muricea atlantica colonies were more severely bleached than Muricea elongata. Preliminary results indicate that both host species harbored strains within the Symbiodinium B184 phylotype. Based on 4 microsatellite loci these species harbor at least 4 (M. atlantica) to 8 (M. elongata) symbiont genotypes, which

differed between host-species. In most cases symbiont genotypes did not change across the bleaching event. These studies are ongoing and additional samples will be collected and analyzed in February and May 2016. These preliminary results suggest that the different bleaching response may be due to the variation in symbiont genotypes between host species implying that a species-specific approach might be needed to address the possibility of an ecosystem composition shift in the Florida Keys.

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LIVING ON THE EDGE: REGIONAL EXTINCTION RISK OF CORAL-DEPENDENT FISHES IN A MARGINAL GULF (Abstract ID: 30006 | Poster ID: 301)

The Arabian Gulf is rich in marine biodiversity and resources that serve to provide important ecosystem functions. However, multiple human and environmental impacts, including coastal development and recurrent bleaching events, have led to the degradation of coral habitat in the Gulf. Fishes dependent on coral reef habitat for survival are thus potentially at an inherently greater risk of regional extinction than species not relying on coral habitat. Despite this, the diversity of coral-dependent fishes within the Gulf and the regional effects of coral degradation on these species had yet to be quantified. Using primary literature and expert knowledge, the coral-dependent fishes of the Gulf were identified and comprehensive data on each of their regional distribution, population status and trends, life history characteristics, and major threats were collated to assess their risk of extinction under the IUCN Red List Regional Categories and Criteria. All coral-dependent fishes with sufficient data to assess were listed at elevated risk of extinction because of the limited area and degraded and fragmented nature of coral habitat in the Gulf. Collaborative efforts among all Gulf States are thus necessary for efficient and effective management and protection of the coral habitats and their associated communities within this globally important region.

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CORRELATING SYMBIODINIUM DENSITY AGAINST THE FIELD BLEACHING ASSESSMENT SCALE TO QUANTIFY REDUCTION IN SYMBIODINIUM ABUNDANCE ON REEFS OF HAWAI'I ISLAND (Abstract ID: 29844)

Coral bleaching data from field assessments are being extensively collected in the face of a current El Niño event that resulted in significant warming of coral reef habitats worldwide. Although many field assessment protocols determine prevalence and severity of coral bleaching in different ways, the field data are seldom extrapolated to biological measures such as actual density reduction of Symbiodinium in coral tissues. The present research correlated Symbiodinium density of three Montipora species across the scale of bleaching severity used by the Hawai'i Division of Aquatic Resources during the 2015 mass coral bleaching event at Wai'ōpae, Hawai'i Island. The density of Symbiodinium in "completely bleached" was 17.3-50.6% and in "pale bleached" tissue was 46.4-107% of that in "healthy" tissue among the three species of Montipora. The Symbiodinium density data were combined with field monitoring data to extrapolate the extent of reduction in the abundance of Symbiodinium due to coral bleaching at the population scale. Having symbiont density values associated with the bleaching scale allows translation of field bleaching data to a measure of biological functionality to assess the impacts of bleaching on coral holobiont physiology and photosynthetic capacity for the whole reef.

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HOW A CORAL PATHOGEN FIGHTS VIRAL INFECTIONS? (Abstract ID: 28037)

The majority of known bacteria are equipped with an immune system that prevents infection by viruses and mobile genetic elements. Foreign intruders are identified via a short fingerprint of their DNA that is stored as a template in the bacterial genome, the so-called "clustered regularly interspaced short palindromic repeats" (CRISPR). We demonstrate that the dominant cyanobacterium in the black band disease mat, is equipped with such a CRISPR immune system. Analyzing CRISPR templates reveals previous bacteriophage infections and provides insights into interactions between viruses and the pathogenic cyanobacteria. Our results suggest that the black band disease mat is a hot spot for viral infections and that cyanobacteria are in a constant arms race with bacteriophages. This presentation summarizes the cyanobacterial CRISPR system and associated DNA fingerprints stored in the cyanobacterial genome. A role for viruses in black band disease has not been previously considered.

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GEOMORPHOLOGY AND HOLOCENE EVOLUTION OF KIMBERLEY CORAL REEFS (Abstract ID: 27916)

The Kimberley Bioregion (North West Australia) is characterised by the largest macrotides of any tropical region in the world (about 11 m), frequent tropical cyclones and high-turbidity. Despite these challenging environmental conditions, the region is also known for extensive and diverse intertidal coral reef habitats. While the area has been recognised as an international biodiversity hotspot, it is still poorly investigated, compared to other reefal ecosystems in Australia, primarily due to its extreme remoteness and lack of infrastructure. A combination of remote sensing, sub-bottom profiling and associated sedimentological work produced a reef geodatabase, providing the first detailed geospatial study of coral reefs within the bioregion. More than 800 reefs have been documented and a geomorphic classification scheme for the Kimberley reefs was developed and includes a new "high intertidal" geomorphic class of reef. Reef coring shows that reef growth began soon after the post-glacial flooding of the antecedent substrate. High-resolution acoustic data, acquired along selected reefs, showed that pre-existing substrate has influenced the successive reef morphology. Global sea-level changes, controlled by ice age fluctuation events, provided a signal which is recorded in successive stages of the reef growth, separated by hiatuses. Two acoustic reflectors can be distinguished, marking the boundaries between Holocene (Marine Isotope Stage 1, last 12,000, 10-20 m thick) and Last Interglacial (MIS5, 125,000 ago, 12 m thick) reefs and an ancient Neoproterozoic rock foundation.

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HOME IS WHERE THE WAVES ARE: CORALS IN GUAM'S EXPOSED REEF FRONTS ARE RESILIENT TO LOCAL STRESSORS BUT VULNERABLE TO REGIONAL WARMING (Abstract ID: 29170)

High coral cover and diversity are typical of Guam's wave-exposed reef-front habitat. This is in contrast to deeper coral communities that have experienced significant declines in cover associated with *Acanthaster planci* outbreaks. Regular exposure to moderate wave energy may mitigate the effect of some stressors, but few data have been available to empirically test this claim. Using data collected at 45 shallow (5 m) sites during a major bleaching event in 2013, Guam's reef front communities were characterized and assessed for bleaching prevalence. These communities generally exhibited high coral and crustose coralline algae cover and low macroalgae and cyanobacteria cover. The stress-sensitive genera *Acropora* and *Montipora* were in greater abundance along exposed coasts, while the stress-tolerant genera *Porites* and *Leptoria* were more abundant along leeward coasts. In comparison, deeper (15 m) communities assessed during NOAA PIFSC towed-diver surveys in 2011 were homogeneous around the island, with low coral and crustose coralline algae cover and higher cyanobacteria and macroalgal cover. While reef front communities appear to be more resilient to local-scale stressors, bleaching prevalence data indicated they were highly impacted by a regional warming event. The substantial number of taxa shared between reef front and lower slope coral communities suggests that the reef front may serve as refugia for some species. However, the vulnerability of reef front communities to thermal stress may diminish their future ability to provide suitable refugia and aid in recovery of Guam's deeper communities.

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LET THE REEF BE YOUR GUIDE: AN ADAPTIVE APPROACH TO MONITORING ON GUAM (Abstract ID: 29106)

Long-term coral reef monitoring programs provide ecological observations essential for both management and research. Effective monitoring programs are question-driven,

achieve sufficient statistical power and confidence, and evolve as new information is obtained. On Guam, a long-term coral reef monitoring program was established to answer managers' questions pertaining to the effectiveness of marine protected areas and watershed management activities, and to assess spatial and temporal patterns in the resilience of Guam's reef systems to climate change-associated impacts. The program uses a split-panel, random-stratified sampling design coupled with standard reef monitoring protocols along with adaptive site boundary determination that is informed by natural environmental regimes. An adaptive approach to site boundary delineation has been critical in determining appropriate stratification and achieving a desired level of statistical power. We demonstrate how benthic habitat homogeneity increased once natural environmental regimes were accounted for. As a result of reformed site boundaries, statistical power ($\Delta = 0.30$, $\alpha = 0.05$) increased multifold for broad level benthic cover categories, including an increase from a power of 0.25 to 0.76 for hard coral cover. Our results highlight the importance of incorporating adaptive capacity into monitoring programs to better focus upon the ecological questions of interest. This effort lends itself to many other monitoring programs that desire to evolve as new information becomes available, and focus on priority questions with increased statistical power.

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THE ROLE OF QUORUM SENSING IN THE PATHOGENESIS OF THE CORAL PATHOGEN VIBRIO CORALLIILYTICUS STRAIN OCN008 (Abstract ID: 29870 | Poster ID: 166)

Vibrio coralliilyticus strain OCN008 has been described as a causative agent of acute Montipora White Syndrome (aMWS), a tissue loss disease affecting the Hawaiian reef building coral Montipora capitata. In laboratory infection trials, infection by the pathogen was cell-density dependent, suggesting that quorum sensing is involved in virulence. The genome of OCN008 appears to encode three quorums sensing pathways described in Vibrio harveyi, LuxP, LuxN and CqsS pathways. Levels of HapR, the high cell-density master regulator common to all three pathways, were shown to be cell density dependent. Deletion of the genes, luxP, luxT, or hapR, from OCN008 attenuated virulence by approximately 50%. Additionally, the production of exoenzymes responsible for lipolytic, proteolytic, and hemolytic activity was greatly reduced in luxP and hapR mutant strains, but not in a luxT mutant. Interestingly, deletion of the gene, aphA, the low cell density quorum sensing regulator, also attenuated virulence by 50% but did not affect exoenzyme activity. Taken together, these results suggest that the expression of certain virulence factors in OCN008 is regulated by quorum sensing and relies on the LuxPQS sensor/synthase pathway. Activation of the LuxPQS pathway at high cell density suggests that a high concentration of bacteria is a requirement for expression of certain virulence factors and full virulence of the pathogen. The infection trial results with the AphA mutant highlight the precisely coordinated manner in which virulence factors must be expressed for a successful infection to occur.

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OVERFISHING, NUTRIENT POLLUTION, AND TEMPERATURE INTERACT TO DISRUPT CORAL REEFS DOWN TO MICROBIAL SCALES (Abstract ID: 29453)

Many stressors, such as local overfishing and nutrient pollution may reduce coral reef resilience by increasing coral-algal competition. Algal competition reduces coral recruitment, growth, and survivorship by several mechanisms, including disruption of coral microbiomes, which may increase pathogen outbreaks, especially during times of thermal stress. Using a multi-year field experiment, we show that overfishing and nutrient pollution disrupt species interactions down to microbial scales, shifting reefs towards algal dominance, and killing corals by sensitizing them to predation, thermal stress, and bacterial opportunism. Excluding herbivorous fishes from reef plots increased algal abundance >4-fold and intensified coral-algal competition. This destabilized coral microbiomes, elevated putative pathogen loads, and increased coral disease >2-fold and coral mortality >8-fold. Adding nutrients also increased algal cover and killed corals by turning normally benign parrotfish predation deadly - a surprising outcome linked to microbial shifts on bitten corals. Thermal stress exacerbated the impact of local stressors, further disrupting microbiomes of unhealthy corals and concentrating 80% of coral mortality in the warmest seasons. However, mortality increased with thermal stress only if herbivores were removed and/or nutrient pollution increased; corals in control plots grew despite similar temperature profiles. These results show how altering important trophic interactions can fundamentally reorganize ecological communities down to microbial scales.

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INSIGHTS INTO CORAL RECOVERY BASED ON SYMBIONT STATE AND ENVIRONMENTAL CONDITION IN THE TEMPERATE, FACULTATIVELY SYMBIOTIC CORAL ASTRANGIA POCULATA (Abstract ID: 28812)

Understanding the dynamics of coral health and the coral-algal symbiosis are becoming increasingly important to coral reef conservation. Here, we examine wound healing as a proxy for coral colony resilience and its potential contribution to coral reef recovery. We used the temperate, facultatively symbiotic coral Astrangia poculata to explore the role of symbiosis (involving Symbiodinium psygmophilum) and the impacts of environmental condition- via changes in temperature (9, 18, 24°C) and food availability (with or without ad libitum feedings of copepods)- on the healing ability of experimentally wounded colonies. Regardless of environmental condition, symbiotic corals exhibited a significant healing advantage over aposymbiotic colonies. Overall, recovery success increased with temperature and with prey availability. This analysis suggests that, with or without the potential for heterotrophy, a relationship with Symbiodinium promotes higher tissue replacement and integrity. Regardless of symbiont state or whether the colonies were fed, we observed minimal decline in total colony tissue cover and no difference between symbiont states under fed and starved conditions. This suggests that colonies in both symbiont states may preferentially allocate energy towards colony integrity when a wound is inflicted. Lastly, significant reductions in healing ability occurred under cold temperatures, suggesting that, in temperate corals- as might be expected- recovery and survivability are more greatly impacted by winter conditions than by exposure to high temperature.

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UTILIZING INNOVATIVE THREE-DIMENSIONAL RECONSTRUCTION TECHNIQUES TO ENHANCE ECOLOGICAL AND BIOLOGICAL STUDIES OF CORAL REEFS (Abstract ID: 28924)

The structural complexity of reefs plays a major role in the biodiversity, productivity, and functionality of coral reef ecosystems. 3-dimensional (3D) analyses vastly improve quantification of the structural complexity of coral reef habitats. We used Structure-from-Motion (SfM) photogrammetry techniques to create 3D reconstructions of Hawaiian coral reefs. The resulting models were integrated into geospatial software in order to quantify metrics pertaining to 3D complexity that are known to affect ecosystem biodiversity and productivity. The 3D structural properties of the reconstructed reefs were statistically analyzed to determine how each coral species and abiotic feature contribute to the structural complexity of the benthic environment. Plating and branching corals exhibited the highest surface complexity, slope, and curvature ($p<0.01$). Temporal analyses were also conducted to assess the impacts of acute disturbances on the volume and 3D architectural complexity of coral communities. Loss of live coral cover was found to directly correlate with reductions in both habitat complexity and volume. Furthermore, these techniques were used to map disease lesions on affected coral colonies in a 3D framework. The lesions exhibited statistically distinct clustering across the surface of the affected colonies, thus providing useful information for characterizing disease epizootiology. These innovative techniques can be utilized for an array of research purposes to improve our understanding of how changes in coral composition and habitat structure affect ecosystem processes.
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MITIGATING THE LOSS OF STAGHORN ACROPORA FROM BLEACHING MORTALITY, USING RESILIENT POPULATIONS (Abstract ID: 29989)

Guam's coral reefs assemblages have experienced bleaching events in rapid succession within the last five years, resulting in unprecedented losses of coral. In particular, bleaching events in late 2013 and June 2014 lead to catastrophic coral death with 100% mortality in some areas. Shallow populations of staghorn *Acropora* corals are confined to reef flats on Guam and suffered from high mortality in these bleaching events. Staghorn corals serve an important ecological role in coral communities due to their ability to create thickets and structurally stable habitats, but are highly susceptible to bleaching. This study aims to conserve Guam's staghorn corals by growing and outplanting coral fragments. After examining the remaining staghorn populations around the island, some have shown recovery and resilience to bleaching. From these populations, approximately 700 fragments of *A. aspera, A. acuminata, A. muricata,* and *A. pulchra* were collected and

placed in an *in situ* coral nursery. Fragments have shown positive net growth and will be compared to source population growth rates. Additional fragments from resilient source populations will be transplanted to experimental plots on reef flats and monitored for growth and thicket formation in order to identify optimal transplant sites. Finally, nursery-grown fragments will be outplanted to enhance reef recovery in sites suffering from significant mortality.

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PERMITTING OF A PIER IMPROVEMENT PROJECT IN HONOLULU HARBOR, OAHU, HAWAI'I (Abstract ID: 28952 | Poster ID: 564)

Hawaii Department of Transportation-Harbors Division (HDOT-H) proposed improvements to two existing piers in Honolulu Harbor. The initial design met the needs of HDOT-H. To comply with the Hawaii Environmental Policy Act and permitting requirements for the Department of Army (DA) permit, AECOS, a local environmental consulting firm, was hired to conduct a biological survey and calculate impacts. The survey found the project would have significant impacts to coral colonies, corals proposed (at that time) to be listed on the Endangered Species Act, and potential acoustic effects on sea turtles and marine mammals. As part of the DA permit, pre-permit consultations were initiated with federal resource agencies and all parties eventually advised that the project would not be permitted as designed. The project was re-designed such that it would have minimal environmental impacts. While impacts would still occur with the new design, in light of the drastic reduction in direct impacts, natural resource agencies approved the DA permit without requiring mitigation. A coral transplant plan was required (and implemented) to avoid impacts. Several years after the initial contract had been let, construction has just begun. From our perspective, we offer the following to improve the permitting process: (1) conduct a biological survey prior to issuing the design contract to better guide the design and (2) establish a mitigation bank to facilitate the permitting process and result in effective implementation of the three steps of mitigation.

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LONG-TERM CORAL REEF MONITORING NEAR A COASTAL TECHNOLOGY PARK IN HAWAII (Abstract ID: 29270 | Poster ID: 690)

The Natural Energy Lab of Hawaii Authority (NELHA) is a state agency in Kailua-Kona focused on research, education, and commercial activities that support sustainable industry development in Hawaii. NELHA construction included large pipelines on the Keahole Point reef to pump cold sea water from a depth of 914 m for research. Since 1989, yearly monitoring has been conducted on benthic biota and fish communities to address impact concerns on the areas widely recognized abundant and diverse near shore marine resources. At six survey sites (three with pipelines and three without) coral abundance and diversity indices were estimated along 50 m transects at depths of 5, 10, and 15 m representing three different habitat zones. Results have shown a gradual increase in coral cover over time (currently 54%) with Pocillopora meandrina (11%) and Porites lobata (35%) always among the dominant species and 11 others making up the remaining 7%. No significant difference between sites or habitats was observed. The fish community was monitored at the same sites and depths with 25 m transects. While the species composition of the fish community was highly variable from year to year, no significant overall changes in species richness (S), evenness (J') or diversity (H') were identified during an 18-year period, with the exception of 2012 in which methods were altered, resulting in an outlier sample. The results of benthic biota and fish studies support the conclusion that the reef community adjacent to the NELHA facility does not appear to be significantly impacted by human-mediated inputs.
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THE FLORIDA REEF RESILIENCE PROGRAM, 10 YEARS OF A PUBLIC-PRIVATE PARTNERSHIP ON THE FLORIDA REEF TRACT (Abstract ID: 29858)

The Florida Reef Resilience Program (FRRP) is a collaborative effort among managers, scientists, conservation organizations and reef users to develop resilience based management strategies for coping with climate change and other stresses on Florida's coral reefs. The FRRP originated in 2005 from discussions among Australia's Great Barrier Reef Marine Park Authority, the State of Florida, the US National Oceanic and Atmospheric Administration and The Nature Conservancy. Since its inception, The Nature Conservancy has coordinated the steering committee of the FRRP, guiding the collaborative effort between fourteen different organizations representing state agencies, federal agencies, universities and NGO's. One of the most important accomplishments of the FRRP has been the increased collaboration between multiple jurisdictions. This has enabled managers to look beyond their jurisdictions placing their respective sites within the context of the entire Florida Reef System. Two efforts of the FRRP, which have been instrumental in fostering this working relationship, have been the Disturbance Response Monitoring Program and support for management planning processes. The DRM has demonstrated how these multiple partners are able to work collaboratively to accomplish results that are much greater than their individual sites while contributing to a greater understanding of the reef tract as a whole. The scientific knowledge and data gathered from this comprehensive coral monitoring has been an invaluable resource to inform the management processes along the Florida Reef Tract.
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THE CAYMAN ISLANDS CORAL REEF RESTORATION EXPLORER (Abstract ID: 29918)

The Cayman Islands Coral Reef Restoration Explorer utilizes multiple models of ecosystem services provided by Coral Reef ecosystems to guide restoration efforts to maximize these services. The ecosystem services models include: tourism, coral connectivity and coastal defense. The Restoration Explorer allows for the planning of coral and mangrove restoration with the focus on enhancing a particular environmental service. The tourism model data represents the number of Photo User Days (PUDs) to estimate the amount of recreation and tourism occurring around the Cayman Islands. The resulting analysis gives an indication of the areas that are most important for tourism. The coral connectivity model used NOAA's Real Time Ocean Forecasting System (RTOFS) ocean circulation model and regional coral reef data to simulate eight coral spawning events from 2008-2011, applying a 30-day pelagic larval duration and 20% mortality rate. Larval dispersal patterns were analyzed between reef units across jurisdictional marine zones in order to identify spatial relationships between larval sources and destinations within countries and territories across the region. Ocean current data were acquired from the NOAA. The Coastal Defense model uses standard engineering techniques to help users estimate how and where to restore or conserve critical habitat, reducing wave impacts and increasing the resilience of the local community and infrastructure.

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PHYLOGENETIC DIVERSITY OF CEPHALOPODA (ANIMALIA:MOLLUSCA) WITHIN THE RED SEA (Abstract ID: 29076)

The Red Sea is a geologically young sea (~5 mya) with a relatively understudied ecosystem compared to other major reef ecosystems. The diversity of Cephalopoda within the reef ecosystems of the Red Sea remains poorly characterized. Cephalopods are found in all the world's oceans, from shallow water to the abyssal plains, and are commonly used as fish bait and consumed by most coastal communities. Despite their abundance and common consumption, the there are few reports of cephalopods within the Red Sea. A small number of field guides have reported a total of 9 octopus, 3 cuttlefish, and 8 squid species based on either sightings or photo ID, but little information is found in published scientific literature for Cephalopoda in the Red Sea. We collected cephalopod specimens within the Saudi coastline of the Red Sea to investigate Cephalopoda species diversity and distributions. Samples were photographed for morphological identification, and then tissue samples were subsequently analyzed utilizing the DNA marker cytochrome oxidase subunit I. We will present results of an integrated morphological and molecular examination of our samples in the context of previously described species. The Red Sea region is known for high endemism in some groups; this study will contribute to an understanding of the role that the Red Sea plays in biodiversity and biogeography of the broader Indian Ocean.

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THERMAL-STRESS REFUGIA FOR CORALS: OBSERVATIONS IN MESOPHOTIC COMMUNITIES OF APO REEF, PHILIPPINES (Abstract ID: 29070)

On top of local scale coral mortalities, climate change induced mass coral bleaching has alarmingly reduced reefs worldwide over the last decades. Coral bleaching, which is pri-

marily caused by anomalous changes in sea surface temperature and irradiance, is commonly reported for euphotic reefs (<20 m) while still generally viewed as less prevalent in mesophotic reefs (≥30 m). However, more studies are needed to determine whether mesophotic coral communities are indeed less susceptible to bleaching. In May 2015, we studied the prevalence of bleaching in coral communities at shallow (~5 m) and mesophotic reefs (~30 m) at three sites in Apo Reef (Mindoro), which at the time of study was in the 'Bleaching Watch' level of NOAA's Coral Reef Watch Program. Based on in situ measurements, sea surface temperatures of the shallow reefs were 2°C higher than the mesophotic reefs in all sites. Bleaching occurred in only one of three sites. A shallow reef of this site registered 31°C and had higher bleaching prevalence among Acropora corals; acroporids were however uncommon at the mesophotic reef. Seriatopora corals also had higher bleaching prevalence at the shallow than at the mesophotic reef. These initial results suggest that deeper sites may serve as refugia for coral communities from thermal stress, and warrants further monitoring of more sites, especially in relation to predicted El Niño-associated sea surface temperature anomalies. Studies on genetic connectivity and other ecological factors between shallow and deep reefs may provide insights on the resilience of reefs in the face of thermal stress events.

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ARE MESOPHOTIC REEFS SAFE FROM EXPLOITATIVE FISHING? (Abstract ID: 29083 | Poster ID: 325)

Reef fish communities are faced with various disturbances, of which destructive and unsustainable fishing practices pose the most direct and immediate impacts. Marine protected areas (MPAs) are among the management measures used to mitigate such impacts, although for pragmatic reasons MPAs are typically located in shallow and more accessible reefs. In the Philippines, reef fish communities at depths >20 m are poorly known and there are no published studies on the potential of deep reefs as refugia from fishing mortality. Here we assess the differences in the structure of reef fish communities (1) between protected areas in deep reefs (25–38 m) and in shallow reefs (8–15 m), and (2) between protected and unprotected deep reefs through underwater fish visual census (FVC). FVCs were conducted at three protected deep reefs (Culasi, Antique; Bayauan, Southern Negros; and Apo Reef, Mindoro) and three nearby protected shallow reefs (Libertad, Antique; Siit, Southern Negros; and Apo Reef, Mindoro). FVC was also conducted in three unprotected deep and shallow reef (Mati, Davao; Calatagan, Batangas; Abra de Ilog, Mindoro). Preliminary results indicate that fish community abundance and biomass are higher in protected deep reefs than in protected shallow reefs. Moreover, the fish community abundance in protected deep reefs is also higher than in unprotected deep reefs; thus deep reefs are also vulnerable to fishing pressure when left unmanaged. Overall, these provide initial indications that protected deep reefs can effectively protect reef fish communities and highlights the importance of extending MPAs to cover mesophotic reefs.

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THE ROLE OF MATERNAL NUTRITION ON OOGENESIS AND LARVAL DEVELOPMENT IN THE CORAL-EATING CROWN-OF-THORNS STARFISH, ACANTHASTER PLANCI (Abstract ID: 29143)

Populations of crown-of-thorns starfish, Acanthaster planci, are predisposed to major fluctuations in abundance due to immense fecundity, high fertilization rates, and short generation times. Variation in environmental and biological conditions that result in fluctuations in larval survival and development can have pronounced effects on recruitment rates and population dynamics. Past studies on A. planci have primarily focused on the direct effects of larval nutrition, while the role of maternal nutrition on reproduction and larval development has been overlooked. In many echinoderms, egg size, fecundity, egg quality, and even larval quality can vary with the nutritional history of adults. To examine the effects of maternal nutrition on gametogenesis and larval development of A. planci, we maintained females on varied diets: starved, preferred coral prey (i.e. Acropora spp.) and non-preferred coral prey (i.e. Porites). Fed starfish increased in weight, had heavier gonads and pyloric caeca, and produced larger eggs compared to starved females. Starfish that fed exclusively on Acropora spp. produced bigger larvae with larger stomachs that developed normally and much more rapidly compared to those from Porites-fed and starved females. Because food quality (coral community structure) and quantity (coral abundance) vary widely between adult A. planci populations in coral reefs, any effect of maternal nutrition on larval quality and survivorship may influence the overall reproductive success of A. planci and help explain marked fluctuations in abundance.

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RECRUITMENT PATTERN OF JUVENILE REEF FISHES IN PUJADA BAY, MATI CITY, PHILIPPINES (Abstract ID: 29504 | Poster ID: 252)

This study was conducted in an attempt to investigate the relationship of benthic attributes to the abundance of fish recruits. A total of 99 transects were surveyed in two sites within Pujada bay from January 2015 to November 2015. Results have shown that species richness was consistently higher inside the MPA (Tamisan) though not significantly different from a non-MPA site (Catmonon). Moreover, both sites were predominated by Pomacentrids. The pattern of abundance of recruits inside the sanctuary peaked during inter-monsoonal period (April, May and October) while peak of recruitment in non-MPA site was during the Northeast monsoon and extended a bit until April. Comparing the relationships of the different benthic composition with the total abundance of recruits, no significant difference was found. This supports the idea that recruits settle randomly in reefs and thus, stochastic in nature. However, with a closer observation for the abundance of pomacentrid recruits alone, during the Southwest monsoon (June-September) the abiotic component (sand and rubble) showed significant relationship with recruit abundance for both sites. Similar pattern was observed during the inter-monsoonal phase in non-MPA site, Catmonan. In Tamisan MPA, hard coral cover showed significant relationship with Pomacentrid abundance. Hence, recruits may also be dependent on the benthic conditions and composition of reefs. In any case, Tamisan as an MPA was showing good contribution for the reefs in Pujada Bay.

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DRIVERS OF REDISTRIBUTION OF FISHING AND NON-FISHING EFFORT AFTER THE IMPLEMENTATION OF A MARINE PROTECTED AREA NETWORK (Abstract ID: 27931)

Marine protected areas (MPAs) are now a common tool in marine spatial planning (MSP) for conserving marine biodiversity and managing fisheries. However, the use of MPAs in MSP often neglects – or simplifies – the redistribution of fishing and non-fishing activities inside and outside of MPAs following their implementation. This redistribution of effort can have important implications for effective MSP. Using long term (14 years) aerial surveys of boats at the California Channel Islands, we examined the spatial redistribution of fishing and non-fishing activities and their drivers following MPA establishment. Our data represents 6 years of information before the implementation of an MPA network and 8 years after implementation. Different types of boats responded in different ways to the closures, ranging from behaviors by commercial dive boats that support the hypothesis of fishing-the-line, to behaviors by urchin, sport fishing, and recreational boats that support the theory of ideal free distribution. Additionally, we found that recreational activities targeted areas that are sheltered from large waves and located near their home ports, while fishing activities also avoid high wave areas but are not constrained by the distance to their home ports. Our work is the first empirical study to analyze the response of both commercial and recreational boats to closure. Our results will inform MSP in better accounting for effort redistribution by ocean users in response to the implementation of MPAs and other closures.

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THE NEED TO FIND CORAL REFUGES IN A CHANGING CLIMATE (Abstract ID: 29481)

Reef corals are suffering from thermal stress in a rapidly changing climate, and in places reefs are failing to keep up with sea-level rise. This research focuses on modeling the distribution of a representative suite of reef-coral species to highlight locations where

corals could potentially survive into the year 2100 under climate change. Species-specific responses for this suite of reef- building corals were modeled using both Bayesian mixed effects and generalized linear models on light and temperature parameters, and using a range of mechanistic constraints. Turbidity was also incorporated into model runs, since moderate levels of turbidity has been shown to lower stress by shading the corals from extremely high light. These models were further modified to determine reef community response to projected climate change if coral species are capable of adapting to a 1oC increase in thermal stress. Twelve clear-water climate-change refuges were identified in the Pacific and Indian Ocean. Turbid refuges aligned with the location of clear-water refuges in the southern hemisphere, but were also identified in the northern hemisphere outside of the clear-water refuges. Modeling the capability to adapt to a 1oC increase in thermal stress decreased the predicted loss into the year 2100, although massive Porites spp., were predicted to increase slightly. Our latest models incorporate genetic connectivity to predict distributions into the future.

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ENVIRONMENTAL FACTORS SHAPE SPACE USE OF CORAL REEF FISH (Abstract ID: 28488 | Poster ID: 518)

Variation in the abiotic environment can shape animal movement because it mediates resource acquisition, reproduction, and competition. For instance temperature governs fish metabolism, while water motion can structure fish community composition, distributions, and foraging ability. Despite the importance of fish space use on key ecosystem processes, the effect of the environment on fish mobility and its implications for reef functioning has not been examined. For 16 months we monitored the movements of 251 acoustically tagged fishes from 39 species within two oceanic reefs in the central Red Sea and quantified their response to changes in water temperature, tides, current, wind speed, and lunar and solar ephemerides. Environmental variables influenced both daily cumulative and maximum distance in a large majority of the fish, but with no detectable pattern across species or trait groups like feeding guild or shoaling behavior. However, we found a number of predictable effects on fish movement in general. An analysis of the network formed between fish and its coral reef habitat revealed that fish visited a larger area of the reef during periods of high tidal amplitude and a smaller area during strong currents. In addition, the overlap of fish spatial niche decreased at high temperatures even though the overall distance moved was not significantly affected, presumably due to a concentration on reef areas of higher productivity. Our results help understand how the role that fish play on reef resilience might be shaped by a changing environment.

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CORAL INTERIOR CARBONATE CHEMISTRY MEASURED WITH PH AND CARBONATE MICROELECTRODES SUGGESTS THAT THE CHEMISTRY OF THE CALCIFYING FLUID AFFECTS RESILIENCE TO OA (Abstract ID: 28076)

Reliably predicting how coral calcification may respond to ocean acidification (OA) depends on our understanding of coral calcification mechanisms and inorganic carbon processing. To better understand these processes, we used pH and carbonate microelectrodes to profile through coral tissue and into the calcifying fluid in three species of coral (Acropora millepora, Orbicella faveolata, Turbinaria reniformis). These first combined measurements of pH and carbonate in corals constrain the inorganic carbon system allowing inference of CO2, total dissolved inorganic carbon (DIC), and alkalinity concentrations. We observed sharp increases in carbonate and pH from the gastric cavity to the calcifying fluid, confirming the existence of a proton pumping mechanism. We also show that corals can achieve a high aragonite saturation state by maintaining high pH while at the same time keeping DIC low. Such a mechanism may require less proton-pumping and energy for upregulating pH compared to the high DIC scenario and thus allow corals to be more resistant to ocean acidification. These results also suggest that differences in calcifying fluid chemistry among coral species may in part explain differences in susceptibility to ocean acidification.

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LIVELIHOOD VULNERABILITY OF COASTAL COMMUNITIES TO CHANGES IN MARINE RESOURCE USE: CASE STUDY OF FIJI AND SOLOMON ISLANDS (Abstract ID: 28683)

Fisheries support the livelihoods of over half a billion people globally. The Pacific Islands are surrounded by the sea, therefore most coastal communities traditionally are highly dependent on marine resources as their main source of animal protein and livelihood. Their dependence on marine resources makes them highly vulnerable to any change in the status of these resources. In this study we examined livelihood vulnerability of coastal communities in Solomon Islands and Fiji to changes in marine resource availability over time. Household surveys, key informant interviews and focus groups were conducted in ten communities in Fiji and nine in the Solomon Islands. Livelihood vulnerability was measured as a function of exposure to changes in marine resource availability as a result of overharvesting and other anthropogenic pressures; sensitivity factors related to dependency on and access to these resources; and adaptive capacity in terms of physical, natural, financial, human and social capital. We find that livelihood vulnerability of households is highly contextual. Remote communities lacking physical and financial capital displayed low vulnerability, and the most exposed community may not necessarily be the most sensitive. However, households that are directly dependent on marine resources are highly sensitive to any decrease and are extremely vulnerable if they have low adaptive capacity. Therefore contextual management approaches that consider the different sources of vulnerability and potential strengths are a necessity in community-based marine resource management.

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A COMPARATIVE NETWORKANALYSIS OF A MARGINAL REEF FROM THE EASTERN PACIFIC PRIOR AND AFTER 20 YEARS OF PROTECTION (Abstract ID: 29761 | Poster ID: 524)

Cabo Pulmo is the northern most coral reef in the eastern Pacific and it was declared as a marine protected area in 1995. It has become an icon of an effective no-fishing area thanks to the support of the local community. Under the hypothesis that after 20 years of effective protection the ecosystem should be more 'mature' sensu Odum, we built two balanced mass trophic models using Ecopath, one with field data gathered in 1998 and other with 2013 data, to compute biomass flow (Total system throughput. T), Production/Biomass (P/B), Ascendency, (A), Overhead (O), development capacity (C) and other ecosystem attibutes. Both models have the same 48 functional groups selected based on their functional role in the ecosystem. Present P/B = 28.507, Total system throughput is 43,343.5 t/km$^2$/year, A = 38,896.0 flowbits, O = 63,281.1 flowbits and C = 116,889.9 flowbits. Even when there has been a notably increase of biomass of the higher trophic level groups and, as expected, current P/B < 1, total system throughput has only increased 1%, Ascendency 4%, Overhead 7%, C 5% and O/C, a measure of system resistance (redundancy), 1%, in comparison with prior to protection condition. This would suggest that either protection not necessarily leads to maturity or it may take longer than expected.
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QUANTIFYING THE CONTRIBUTION OF SEA URCHINS TO THE BIOEROSION OF HAWAIIAN CORAL REEFS (Abstract ID: 29777)

Bioerosional processes from urchins can contribute significantly to the destruction of reef geomorphology, shifting the balance between erosion and accretion necessary for the persistence of coral reefs. We estimate the relative contribution of sea urchins to benthic erosional processes inside and adjacent to a long-term no-take MPA in the Hawaiian Islands, hypothesizing that bioerosional contributions would be dominated by sea urchins outside of the reserve, where urchin predators are targeted by fisheries. At 50 sites inside and adjacent to the 'Āhihi Kīna'u Natural Area Reserve, divers observed the size frequency of urchins using standard visual survey methods. Empirically-derived relationships

between bioerosional rate and body size were then used to estimate the total bioerosional contribution for urchins based on their size-specific densities at each site. Urchin communities were dominated by the rock-boring urchin Echinometra mathaei and the red slate pencil urchin Heterocentrotus mamillatus with lower densities of five other urchin species. A better understanding of the bioerosional contribution of urchins provides vital information for the understanding of thresholds in the accretion-erosion dynamics of coral reefs.

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APPLICATION OF SATELLITE SST-BASED CORAL DISEASE OUTBREAK PREDICTIONS FOR HAWAII (Abstract ID: 28853)

Remote sensing of sea surface temperature (SST) has become increasingly valuable for identifying threats to coral reefs in recent years. Here, we compare field observations with satellite-based predictions of disease prevalence for the three most common coral diseases in Hawaii: Montipora white syndrome, Porites growth anomalies and Porites tissue loss syndrome, with data collected from 18 Hawaiian Islands and atolls between 2004 and 2015. Our predictive boosted regression tree models were created using ~4km SST data and site level measurements (e.g., host density), and predicted disease risk up to 6 months prior to an expected outbreak event. Our results suggest winter pre-conditioning and host density are key drivers of disease susceptibility. However, the relative influence of seasonal thermal metrics varied with the specific disease. Coral disease outbreaks often occur subsequent to bleaching events, although the underlying relationship explaining this pattern remains unclear. In light of the recent mass coral bleaching in Hawaii, it will be useful to closely monitor coral health in the upcoming year. Experimental coral disease outbreak tools are currently available through NOAA Coral Reef Watch; the models here can improve interpretations of the near real-time products for these Hawaiian diseases. This enhances management capacity to prepare for and respond to emerging coral diseases and can be modified for other diseases and regions around the world. Additional remotely sensed parameters, such as ocean color metrics, could enhance such models in the near future.

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REEF FISH SURVEY TECHNIQUES: ASSESSING THE POTENTIAL FOR STANDARDIZING METHODOLOGIES (Abstract ID: 29872 | Poster ID: 270)

Dramatic changes in reef fish populations have been documented globally and, in response, the research community has initiated efforts to assess and monitor reef fish assemblages. A variety of visual census techniques are employed, however results are often incomparable due to differential performance of methods. Although comparability of data may promote improved assessment and management of nearshore fisheries, to date no standardized and agreed-upon survey method has emerged. This study aims to describe the use of methods across the research community and to test potential factors linked with selection of method. An online survey was distributed to researchers from academic, government, and non-government organizations internationally. Although many methods were identified, 89% of survey-based projects employed one of only three methods – belt transect, stationary point count, and some variation of the timed swim method. The selection of survey methods was found to be independent of the research design (assessment goal) and region of study, but related to the researcher's home institution. While some researchers expressed willingness to modify their current survey protocols to more standardized protocols (76%), their willingness decreased when methodologies were tied to long-term datasets of ongoing projects of 5 or more years. Willingness to modify current methodologies was also less common among academic researchers than resource managers. By understanding both the current application of methods and the reported motivations for method selection, we hope to focus discussions towards increasing the comparability of quantitative reef fish survey data.

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NIGHTTIME DISSOLVED OXYGEN SPIKES ACROSS CORAL REEF ENVIRONMENTS: BIOLOGICAL OR NOT? (Abstract ID: 28946)

Light driven photolysis of water is believed to provide all the elementary oxygen found in nature. The evolution of photosynthesis, the only known biological photolytic process, profoundly shaped the face of this planet. This has led to the assumption that photosynthesis is the only significant source of ecological primary production, and the main input to consider when calculating a total ecosystem oxygen budget. However, during our attempts to calculate just such a budget, a prevalent, globally observed spike in dissolved oxygen concentration occurring at night altered our assumptions regarding primary production. These spikes have been observed across a multitude of tropical environments over many years, as evidenced by our own research and an exhaustive literature survey of studies involving high resolution, overnight dissolved oxygen measurements. Calculating a complete and accurate oxygen budget will need to include the contribution of these nighttime dissolved oxygen concentration spikes where ever they occur, regardless of whether they are biotic or abiotic in origin. Using a combination of field and experimental measurements, we show that: 1) this phenomenon can be isolated in vitro using benthic samples collected from a coral reef, 2) it is strongly associated with crustose coralline algae, and 3) it cannot be explained by a purely abiotic process. This leads to the prediction of a biological source for these nighttime dissolved oxygen spikes, and suggests that a process other than canonical photosynthesis may be involved.

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PILOTING A WATERSHED-SCALE MODEL FOR COLLABORATIVELY ADDRESSING LBSP STRESSORS ON CORAL REEFS IN WEST MAUI, HAWAII, USA (Abstract ID: 28492)

In response to the complexity of stressors contributing to the decline of live coral in West Maui, Hawaii, USA and the need to go beyond managing ocean pressures to addressing land based pollutants, a collaborative partnership cutting across jurisdictions and interests called the West Maui Ridge to Reef Initiative (R2R) was formed in 2012. The network of partnerships in the R2R including those enabled through US Coral Reef Task Force and State priority watershed designations have been central to early successes and shared lessons learned in the region. The R2R is led by federal and state agencies that provide funding and oversight for watershed management planning and implementation in West Maui, as well as technical and research support. However, without the support from the community, landowners, and other local stakeholders, the buy-in is missing for implementation of proposed mitigation strategies. As a result, a local working group representing targeted land and ocean interests was formed to provide practical insights that facilitate the transition from watershed planning to implementation. A loosely defined Hui (team) of non-profits, researchers and consultants carry out recommended strategies on a project by project basis. Lessons learned to date follow themes universally relevant to watershed managers, such as the importance of sufficient scientific information, the barrier maintenance presents where capacity is limited, the importance of an institutional support structure and the degree of community and local government engagement needed to remain relevant.
http://www.westmauir2r.com/

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ACROPORA CERVICORNIS SEXUAL CORAL REPRODUCTION TO COMPLEMENT THE RESTORATION PROGRAM IN NURSERIES IN THE DOMINICAN REPUBLIC (Abstract ID: 28395)

In recent decades there has been a reported decline in the abundance of corals worldwide. As part of a strategy to reduce the degradation of reefs and contribute to the recovery of diminished coral populations, nurseries and areas of transplanted coral fragments have been established in different parts of the world. In the Caribbean Acropora cervicornis loss has resulted in a reduced ability to successfully reproduce both sexually and asexually. In the Dominican Republic there are coral gardening programs of restoration, growth and transplant of A. cervicornis. The sexual reproductive maturity of this species in coral nurseries has been evaluate in order to supplement the program. Histological sections of fertile polyps confirmed the maturity of the gonads prior to spawning. Collection of gametes and assisted reproduction was conducted as well as the observation and documentation of the stages of embryonic development, larval development, larval settlement and metamorphosis into primary polyps. Currently, tests are underway for the incorporation of symbionts. It was documented that in nurseries the largest fragments had the highest percentage of spawning, presenting a lower rate of growth, while fragments that did not spawn showed a higher rate of growth. It is important to combine restoration techniques not only to restore degraded areas but also to ensure the genetic diversity of the species.

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LEGACIES OF THE PAST FEED MISMATCHES BETWEEN REGULATIONS AND CORAL REEF FISHERIES (Abstract ID: 30142)

Fisheries regulations should evolve in response to improved science and the changing dynamics of the fisheries in question. However, the legacy of past regulations may still manifest themselves when they are no longer appropriate. This may be particularly evident in small-scale fisheries in developing island nations where resources and capacity to respond are limited. As a case study, we investigated the fisheries legislation of the Turks and Caicos Islands in order to identify any mismatches with the fisheries they are designed to regulate, and to assess the obstacles preventing these mismatches from being rectified. Numerous mismatches were evident, particularly for the most economically important fishery, spiny lobster (Panulirus argus). Some long-standing regulations have become culturally engrained, and are enshrined along with an outdated or incorrect understanding of the species' ecology. Confronting these mismatches would be met with heavy resistance, and could also jeopardise the credibility of the management authority.

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CHANGES IN THE ULTRASTRUCTURE OF THE CORAL *POCILLOPORA DAMICORNIS* EXPOSED BY HIGH TEMPERATURE, ULTRAVIOLET AND FAR-RED RAYS (Abstract ID: 28600 | Poster ID: 427)

Light and temperature are known stressors causing the collapse of coral-algal symbioses. However, it has been poorly understood how these stressors induce coral degradation in an early stage. Here we investigated ultrastructural changes in coral tissues and symbiotic zooxanthellae under high temperature (HT), ultraviolet (UV) and far-red (FR) rays. Coral was collected from Tosa Bay, Japan and small fragments were maintained in glass dishes with sterilized seawater at ambient room condition. Regenerating corals were placed on 32C water bath, while other exposed to UV-A (4.5 w/m2) and FR (2.0 w/m2) rays. After 15min–48h treatments, samples were fixed and embedded in resin. Thin sections were observed with TEM. In control, coral tissue was generally intact that consists of epidermis and gastrodermis interconnected by acellular matrix mesoglea. Zooxanthellae were enclosed by two membrane-like structures in the cytoplasm of gastrodermis. There were few autophagosomes and lysosomes in the coral tissues. After 6h exposure to FR and UV-A, dark granules appeared along with vacuolization of gastrodermal cells. Prolonged light treatments brought brought about fragmentation and destruction of cytoplasmic contents. This eventually led the collapse of gastrodermis then release of gastrodermal cells containing zooxanthellae in the gastric cavity. Zooxanthellae were remarkably affected where thylakoids and cortical membranes partially rupture. Autophagosome densities gradually increase. Treatment with HT also induced gastrodermal degrdadation, zooxanthellae disruptions and autophagic structure.
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MANGROVE HABITATS SELECT CORAL POPULATIONS TOLERANT OF PH AND TEMPERATURE CONDITIONS PREDICTED FOR REEFS UNDER CLIMATE CHANGE (Abstract ID: 28099)

Corals can persist in environments that are considered extreme and approach the edge of conditions where corals normally thrive. Within tropical reef systems, mangrove habitats routinely experience reduced pH and elevated temperature that effectively parallel (or exceed) climate conditions predicted over the next 100 years. Corals persisting among mangroves are thus potentially "future proofed" but to date have been largely unstudied. Exactly how corals are able to survive under these extremes is unknown. We present data from two reef-adjacent mangrove systems from the Indian (Seychelles) and Pacific (New Caledonia) Oceans. As expected, coral diversity and abundance is lower among the mangroves than on the neighbouring reef. However, several species observed in the mangroves are those that comprise the main neighbouring coral reef framework. Novel "pH-performance assays" for key coral species demonstrated that mangrove populations appear to thrive by diel downregulation of metabolic processes during the most extreme pH-temperatures, whereas reef populations attempt metabolic regulation that incurs a cost to their overall fitness. We also identify how high organic content, paralleled with increased respiratory metabolism, suggests that heterotrophic plasticity is important in facilitating coral acclimatisation to combined hot-acidic waters. Together these data reveal key physiological traits potentially required for corals to survive climate change. We also highlight present day coral populations that could become central to future reef restoration programs.

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CAN ANYONE BE A SCIENTIST? EXPLORING THE ROLE OF CITIZEN SCIENCE IN CORAL REEF RESEARCH (Abstract ID: 29893)

Individuals lacking scientific training have made important contributions in many disciplines historically, but the role and value of public participation in modern professional research is controversial within the scientific community. Beneficially, citizen scientists provide a source of labor, a variety of skills, and capital, for example, paying to spend their vacations participating in environmental and ecological research. This link between the public and research serves as a bridge between science and education, creating a more environmentally informed populace. Additionally, citizen science is becoming a major supplement to undergraduate degree programs, providing opportunity for students to acquire applied field experience. At the same time, the contributions of non-scientists are questioned and more easily dismissed by the scientific community on the basis that the data they collect may not be accurate. Through a survey of participants, organizers, and scientists, this study evaluates and compares the role of both public and student-oriented citizen science in coral reef research, with a case study focused on the Central Caribbean Marine Institute on Little Cayman Island, at which the lead author participated in an ongoing National Science Foundation Research Experience for Undergraduates program. We examine stakeholder perceptions, interest, engagement, quality of experience, and outcomes, with the goal of identifying challenges and opportunities that, if addressed, could optimize the use and effectiveness of citizen science programming, and resulting outreach.

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ACOUSTIC DIVERSITY AND BEHAVIOR OF CORAL REEF FISH AGGREGATIONS FROM SONAR SURVEYS (Abstract ID: 29625)

Coral reef ecosystems are among the most diverse and productive in our oceans. Over 4000 species of teleost fishes are associated with coral reefs, raising challenges to monitor the abundance and the distribution of reef fish in order to develop an effective conservation policy and to evaluate the effect of management actions. Fisheries acoustics is one of the tools that is widely used in fishery assessments, but remote species identification is challenging in diverse reef systems with limited studies on acoustic characteristics of reef species. The work proposed here is an attempt at improving the marine ecosystems acoustics for the study of coral reef fish communities. We review long-term marine ecosystem acoustic surveys in the US Caribbean and evaluate metrics that describe behavioral patterns and species-specific acoustic characteristics of coral reef species. Based on these metrics, schools and aggregations were clustered into 5 distinct groups. The use of underwater video surveys from a Remote Operating Vehicle (ROV) conducted in the proximity of the acoustic observations allowed us to associate the clusters with broad categories of species groups such as large predators, including fishery important species to small forage fishes. The distribution of the clustered aggregations was then paired with habitat–related metrics derived from multibeam surveys in order to evaluate the association of coral reef species with habitat complexity that could further improve species classification during acoustic surveys and develop predictive models of species distribution. Challenges and possible applications of the approaches used in this work are presented and discussed.

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THE RESPONSES OF CALCIFIED GREEN ALGAE (*HALIMEDA* SPP.) TO CLIMATE CHANGE STRESSORS (Abstract ID: 29495)

Ocean acidification (OA) stands to influence the physiological functioning of a variety of marine calcifiers. While many of these responses have been documented for reef invertebrates, we know relatively little about the responses of other taxonomic groups, primarily calcified green algae. Furthermore, in addition to elevated $CO_2$, the interactive effects of alternate environmental parameters (e.g. temperature) are just now being investigated, which can add complexity to previously documented responses. We present a series of mesocosm experiments that describe both the singular and combined effects of OA and thermal stress on several species of calcified green algae. Multiple experiments with *Halimeda incrassata*, *Halimeda simulans* and *Halimeda opuntia* were conducted in independent tanks which replicated a variety of $pCO_2$ (400-1400 ppm) and temperature treatments (28-31°C). Measured responses included calcification (alkalinity anomaly and buoyant weight), photosynthetic output (oxygen evolution), and mineral $CaCO_3$ content (gravimetric acidification). Data show that while calcification generally declined with OA for multiple species, elevated temperature had an opposing effect, serving to increase both calcification and photosynthetic production. Thus, in certain

cases, elevated temperature (+3°C) may mitigate OA effects. Subsequent experiments with *H. opuntia*further reveal linear increases in net calcification with temperature, thereby highlighting the importance of other environmental parameters on OA responses. http://www.sms.si.edu

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WATERSHED RUNOFF AND SEDIMENT RESUSPENSION: FACTORS AFFECTING TURBIDITY AND SEDIMENTATION IN BAYS WITH CORAL REEFS, ST. JOHN, USVI (Abstract ID: 29153 | Poster ID: 438)

Land-based erosion and terrigenous sedimentation is a major coral reef stressor in the USVI. On St. John, land development has increased sediment yields and marine terrigenous sedimentation by up to an order of magnitude above background. Once deposited, resuspension of benthic sediment may further increase turbidity and deposition (T-D). However, isolating the relative contributions of runoff vs. resuspension using conventional sediment trap monitoring has proven challenging. Here we describe the spatial variability of marine sediment dynamics in response to runoff vs. resuspension events in St. John and compare monthly vs. high-resolution monitoring approaches. Nephelometers (10-min. res.) were deployed beside sediment traps (~monthly res.) at three reef and four shoreline sites next to ephemeral stream outfalls equipped with water level sensors (10-min. res.) and peak crest gauges (~2-week res.). Monthly mean sediment trap accumulation rates and nephelometer data were strongly correlated. Runoff events resulted in high-magnitude (up to 900/17,000 times background) but short-lived (hours) spikes in T-D. Resuspension-induced spikes in T-D were lower in magnitude but longer (days-weeks), particularly at sites with finer-grained benthic sediments, and were associated with increased wave height during low tides. While the relative contribution of runoff vs. resuspension to T-D was spatially variable, both processes produced responses that greatly exceeded water quality standards and coral stress thresholds for short timeframes (hours to days).

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CLIMATE VARIABILITY AND THE RESILIENCE OF LOW DIVERSITY CORAL COMMUNITIES TO BLEACHING IN THE GILBERT ISLANDS, KIRIBATI (Abstract ID: 28273 | Poster ID: 207)

Ocean warming due to climate change threatens to cause frequent coral bleaching and degrade coral reefs across the Pacific. Recent research has suggested that past temperature experience, including exposure to variable temperatures and/or frequent heat stress, confer greater resilience to climate change. The central equatorial Pacific, where the El Niño / Southern Oscillation, drives year-to-year shifts in current strength, current direction and consequently ocean temperatures, is an ideal natural laboratory for evaluating the influence of past sea surface temperatures (SST) on the susceptibility of individual corals and coral communities to heat stress. This presentation describes changes in the coral community over the past decade, including multiple El Nino-driven heat stress events, in the little-studied Gilbert Islands of Kiribati. Changes in benthic cover, coral size distribution as well as the bleaching index (for the 2009-2010 El Niño) are contrasted between a matrix of sites exposed to different levels of SST variability and human disturbance across four atolls. Spatial analysis shows that patterns in coral bleaching are best correlated with light and the coefficient of variation of past sea surface temperatures, rather the magnitude of heat stress during the El Niño event (e.g. degree heating weeks). The long-term data indicates that reefs subject to the combination of high human disturbance and high temperature variability are the most resilient to heat stress, due to the presence, and continued expansion, of the "weedy" species Porites rus.

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FREQUENCY OF MAJOR STRESS EVENTS ON THE GREAT BARRIER REEF: LONG-TERM TRENDS IN CALCIFICATION AND COMMUNITY COMPOSITION AS INDICATORS OF REEF RECOVERY (Abstract ID: 29843)

Defining, measuring and monitoring coral reef health is fundamental to understanding the future of coral reefs in a changing ocean. Long-term trends in reef health improve our understanding of how dynamic reef processes alter the composition and productivity of reef ecosystems in order to identify resilient reef habitats for management. In this study we combine two key indicators of coral reef health, annual trends in colony calcification rates and benthic composition and cover, with environmental factors to document and assess the frequency of major disturbances and their impacts across decadal and century time-scales. Calcification rates for the Great Barrier Reef suffered an 11% decline between the late 20th and early 21st century, following two major widespread bleaching events in 1998 and 2002. Calcification records from a subset of these coral colonies, collected a decade later, indicate that calcification rates recovered from these thermal stress events within 3-4 years, returning to baseline calcification rates. These skeletal growth records provide a long-term assessment of how individual coral colonies respond to stress events, enabling us to quantify rates of recovery. In this presentation we will compare trends in coral calcification with shifts in community composition to understand and define the frequency and severity of major disturbances and assess recovery trends on reefs along the Great Barrier Reef.

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SEASONAL VARIATIONS IN STABLE ISOTOPIC VALUES OF PARTICULATE ORGANIC MATTER FROM LUHUITOU FRINGING REEFS, SOUTH CHINA (Abstract ID: 27837 | Poster ID: 305)

Coral reefs have suffered remarkable declines of both coral cover and coral species worldwide. Nutrient over-enrichment is considered to be one of the causes of coral decline. Luhuitou fringing reefs, south of Sanya city, is a famous tourism spot and much influenced by anthropogenic activities. This study reviews current nutrient status of fringing reefs in South China and evaluates primary nutrient sources using stable isotopic method. Results show that δ13C and δ15N values of particular organic matter (POM) are statistically significant with seasons. In dry seasons (spring and winter), there are more terrestrials and anthropogenic-derived nutrients; and in wet seasons (summer and autumn), there are more marine derived nutrients. The overall δ13C values suggest marine and terrestrial-derived nutrient sources. Organic carbon is a mixture of marine phytoplankton, marine benthic algae and terrestrial-derived plants. The δ15N values suggest terrestrial-derived sewage and upwelling-dominated nitrogen sources. In the presence of natural upwelling and coastal currents, coastal coral reef areas are more vulnerable to the increasing anthropogenic nutrient inputs. These results provide some understanding of the declining coral reef ecosystem and the importance of conservation areas and coastal coral reef resource management.

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HITCHHIKING IN THE SEA: EVIDENCE OF VECTORS TRANSPORTING THE INVASIVE CORAL SPECIES TUBASTRAEA COCCINEA AND T. TAGUSENSIS IN THE SOUTHWESTERN ATLANTIC OCEAN (Abstract ID: 29676)

Human activities are responsible for an unprecedented connectivity in the marine environment. The opportunistic and highly competitive invasive species Tubastraea coccinea and T. tagusensis were first recorded in Brazil in 1980 on oil platforms and have spread over 3,000km, including oil platforms and monobouys. This study presents the first data on the genetic diversity and population structure of both species from rocky shores, oil platforms and a monobuoy along the Brazilian coast using 11-12 microsatellite loci. A high number of clones were found for both species, particularly in the coastal populations. The occurrence of repeated MLG and small values of genotypic richness observed at coastal populations indicates that these are most clonal, originated mainly from asexual reproduction. Despite the small number of individuals, in both species the vectors had the highest allelic diversity and expected heterozigosity compared to rocky shores, which is the expected for source populations. A lack of population structure was detected for T. tagusensis, which might be explained by introductions from the same native population. Conversely, five genetic clusters were recovered for T. coccinea, which might be associated with the occurrence of multiples introductions. These findings are expected, as T. coccinea is cosmopolitan while T. tagusensis has a more restrict distribution. Results show that the coast, oil platforms and monobouys share alleles, indicating that the latter two have relevant roles in the spreading of both invasive species along the Brazilian coast.

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PHYSIOLOGICAL STRATEGIES TO ACCLIMATISE TO HIGH SEAWATER TEMPERATURE STRESS WHEN HOSTING DIFFERENT SYMBIODINIUM (Abstract ID: 29165)

One mechanism to survive bleaching events is for the host to shuffle to a more thermally tolerant Symbiodinium clade D. Studies have shown that corals shuffle back to Symbiodinium clade C (thermally sensitive) months after heat stress disappears suggesting that there is a tradeoff for corals. But the interactive physiology and fitness benefits of hosting clade D are poorly understood. The South of Taiwan provides a perfect scenario to study the influence of high SST. At the nuclear power plant outlet (OL) in Kenting, there is a constant hot water effluent with an average SST during summer of 2.0–3.0°C higher

than at other sites. In this research with the use of reciprocal transplantation experiments (RTE) the physiological processes of*Leptoria phrygia*, coral that associates with clade D at the OL and clade C in Wanlitong, a site that is not influenced by hot water stress, are being monitored during 18 months. Growth rate, chlorophyll a fluorescence, algae density, protein, and lipids are being measured and compared with *Porites lutea*, a specialist species that associates with the stress-tolerant Symbiodinium clade C15 to understand the different physiological strategies corals have. Preliminary results indicate that only those corals transplanted from Wanlitong to OL that were able to shuffle to clade D survived the hot water stress during the summer. And those corals transplanted from OL to Wanlitong are performing better than the control group. This study will help determine how corals will acclimatise to high SST under future climate change scenarios.

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## BACTERIAL VIRULENCE GENE EXPRESSION UNDER HIGH CONCENTRATIONS OF DOC PROVIDES INSIGHT INTO THE PATHOGENIC SWITCH IN OPPORTUNISTIC MICROBES (Abstract ID: 28679)

Algal cover in tropical coral reefs has increased worldwide leading to the alteration of the biogeochemical cycling and microbial metabolism, by the release of DOC-rich exudates. Algal exudates support the growth of virulent bacterioplankton populations, which consequently affect reef health deterioration and disease emergence. However, these same bacterial populations are also associated with healthy reefs, where they fulfill key functions to support the ecosystem. To date there has been no compelling evidence correlating environmental conditions triggering virulence in these opportunists. To shed light on this matter, we evaluated microbial gene expression of the most dominant microbial populations under elevated concentrations of dissolved neutral monosaccharides (DNM) naturally present in algal exudates. Through metagenomic sequencing, we successfully assembled 3 near-complete (>95%) and 20 population genomes (>50%) representing from 14.2 to 30.6% of the community. Bacterial mRNA reads were isolated, sequenced, and mapped to the recovered genomes to determine differential gene expression. The differential gene expression analysis showed a high number of genes involved in pathogenesis during the DNM enrichments, including genes encoding cholera-like toxins and proteins involved in hydrogen sulfide synthesis. Our findings suggest that elevated concentrations of DNM act as a driver of expression of virulence genes in coral reef ecosystems and provide a mechanistic explanation for a functional switch of opportunistic to pathogenic bacteria.

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## ASSESSING MITIGATION EFFORTS TO REDUCE SEDIMENT RUNOFF ON CORAL REEFS IN ST. JOHN, USVI USING CORAL GEOCHEMICAL PROXIES (Abstract ID: 28376)

Coral reefs have declined dramatically in the US Virgin Islands (USVI) over the past several decades. Sedimentation is a major stress to USVI coral reefs. Previous work found increased terrigenous sedimentation below developed watersheds in St. John. Erosion control measures recently put in place appear to be at least partially effective. To determine whether mitigated sediment runoff has reached pre-development levels, we are reconstructing historical proxy-based sedimentation records using geochemical signatures in coral cores. We will compare changes in proxy-based sedimentation records over time as well as between Coral Bay (a developed watershed) and Lameshur Bay (a relatively undeveloped watershed), allowing for comparison of how land use change has increased sedimentation in a recently developed watershed. Long-term records of sedimentation onto reefs in St. John based on metal/Ca records from Siderastrea siderea coral cores will be presented, in addition to results from a replication study from multiple short coral core-tops collected adjacent to one another. Cores were also collected adjacent to sediment traps that have recorded seasonal changes in sedimentation over multiple years, thus allowing the possibility of ground-truthing the proxy-based records to actual sediment runoff quantities. Understanding the efficacy of various erosion control methods is vital to controlling anthropogenic inputs in other watersheds. The records constructed here will provide feedback for watershed management strategies employed on St. John and other similar high islands.

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## INTEGRATING WATERSHED AND HYDRODYNAMIC MODELS TO QUANTIFY LAND-DERIVED SEDIMENTATION ON REEFS (Abstract ID: 29256)

Land-based sediment transported by rivers and plumes is a major cause of coral reef destruction. However, there are very few integrated quantitative studies that can be used to track sediment transport between land and sea realms. To address this gap, quantitative watershed and hydrodynamic models were linked to describe the sediment exposure of coral reefs in El Nido, Philippines. We used the Soil and Water Assessment Tool to identify critical watersheds that had high sediment yield. We then inputted the sediment load data to Delft3D Flow model to estimate dispersal and deposition of suspended sediments by river plumes. We calibrated and validated the models using low cost water level and light sensors to ensure accuracy of estimated discharge and suspended sediment concentration. We then estimated the exposure of coral reefs to sedimentation by using different scenarios of land use, precipitation, winds and ocean variability. We found that high discharge plume boundaries covered areas in the North of the inner Bacuit Bay, wherein some reefs and islands are used for tourism. This sediment is predominantly Coron-Malalag clay and sourced from a subbasin which is 47% shrubland, 30% forest and 23% mangrove. Hydrologic retention time in the North embayment is relatively long, causing extended periods of turbid water episodes. This study highlights the utility of quantitative models to describe the effects of land-based activities on reefs, and the importance of integrated studies in order to manage sedimentation and land-sea interactions more effectively.

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## DEFINING SUCCESS IN ACTIVE CARIBBEAN ACROPORID POPULATION REPLENISHMENT EFFORTS: RESULTS FROM OVER NINE YEARS OF WORK IN SOUTHERN BELIZE (Abstract ID: 27909)

Coral restoration efforts are becoming more accepted as an active management tool but still lack a realistic sense of scale, and quantifiable, comparable, success indicators. Specific active replenishment goals are to restore lost ecosystem services like shoreline protection, fisheries enhancement, biodiversity preservation, and provisioning of aesthetic and economic services for the tourism industry. Continuity is key to ecosystem service values, which requires that the restored coral community be (1) self-sustaining and self-propagating, and (2) resilient against persistent insults. Genetic diversity must be addressed regardless of propagation methods. How much genetic diversity is needed? What amount of coral coverage, and where, is needed to trigger natural regenerative processes at larger scales? Presented here are data from over nine years of acroporid restoration efforts at Laughing Bird Caye National Park, Belize, where over 26,000 nursery-grown acroporid fragments have been out-planted. Data were acquired on host and algal clade diversity, growth rates and survival, bleaching history, reproductive indicators, methods for measuring live coral cover over time, methods to assess changes in fish biomass on out-planted sites, and mechanisms to include local community members in the work. We suggest realizable goals and success indicators, offer guidance for expanding restoration efforts to new sites, and recognize Marine Protected Areas and stakeholder involvement as key to coral restoration.

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## GROWTH AND DEMOGRAPHY OF THE MEDITERRANEAN ENDEMIC SOLITARY CORAL *BALANOPHYLLIA EUROPAEA* LIVING ALONG A NATURAL $PCO_2$ GRADIENT (Abstract ID: 28605)

Increasing research effort on marine calcifying organisms is important and urgent, given the projected $CO_2$-driven ocean acidification for the coming century. Here we assess the

growth and population dynamics of the Mediterranean endemic zooxanthellate solitary coral *B. europaea* at three sites along a natural $pCO_2$ gradient of the volcanic vents off Panarea Island (Italy), in the Mediterranean Sea. *B. europaea* was the only scleractinian found along the gradient and its abundance decreased with increasing $pCO_2$. The age-length relationships, obtained for each site by sclerochronology through computerized tomography, resulted homogeneous and then data were pooled to obtain a general age-length relationship. Skeletal linear extension rate and bulk skeletal density were measured and net calcification rate was calculated for each sample at each site. While linear extension rate did not vary with $pCO_2$, bulk skeletal density and net calcification rate decreased with increasing $pCO_2$. The population age structure was obtained by analyzing photoquadrats and several observed and theoretical demographic parameters were derived (age structure stability, instantaneous rate of mortality, average age, % of immature individuals, age at maximum biomass, average age of biomass) and compared among sites. Populations showed a deficiency of young individuals with increasing $pCO_2$. The species seems sensitive to ocean acidification even if the photosynthetic efficiency of its symbionts increases with $pCO_2$, suggesting an even higher sensitivity for shallow water non-zooxanthellate scleractinians.

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A 3000 YEAR RECORD OF ABUNDANCE AND DYNAMICS OF THE KEYSTONE URCHIN DIADEMA ANTILLARUM FROM ANALYSIS OF SUBFOSSIL SPINES FROM REEF SEDIMENT CORES (Abstract ID: 30055 | Poster ID: 5)

The long-spined sea urchin Diadema antillarum has been described as a keystone grazer in Caribbean coral reef ecosystems. In the 1980s an unknown pathogen resulted in a mass die-off that caused a near extinction of this population across the Caribbean, catalyzing an explosion in macroalgal cover that led to a region-wide decline in coral abundance. Because of Diadema's importance as the last abundant reef herbivore following the overfishing of herbivorous fishes and its failure to recover following the mass dieoff, it is important to understand its baseline abundance and prospects for future recovery. However, little is known of the natural dynamics of this species due to the lack of a historical baseline. We reconstructed a 3000 year record of Diadema abundance by isolating and weighing spines preserved in reef matrix cores collected from three reefs in Bocas del Toro, Panama. We found that Diadema was a consistently rare component of the urchin community at the midslope zone (6-8m), comprising only 3% of total urchin spine weight on average. Diadema abundance was closely linked to reef accretion rates, indicating its strong reliance on coral-dominated habitat. Other than declines associated with declines in reef accretion, we did not find any evidence of previous mass dieoffs. We also found no evidence of an increase in Diadema abundance over the historical period due to prey release from overfishing. These results reveal that Diadema's failure to recover following the dieoff may be related to the degradation of coral habitat in subsequent decades.

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ENVIRONMENTAL DAMAGE TO CORAL REEFS IN THE SOUTH CHINA SEA AND INTERNATIONAL ARBITRATION UNDER THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA (Abstract ID: 29776)

Recent island building activities and unrestrained exploitation on the reefs of the South China Sea raise questions regarding national obligations under international treaties. An historic test of these obligations under the United Nations Convention on the Law of the Sea (UNCLOS) was heard before the UN Permanent Court of Arbitration at the International Court of Justice in the Hague in November, 2015. Evidence was presented to document the extensive coral reef damage from dredging for island building in the South China Sea. Scientific evidence indicates that this damage to coral reefs is likely to influence reef productivity throughout the region, including in adjacent exclusive economic zones. Additional evidence of unrestrained exploitation targeting giant clams, corals and reef fishes was presented that are indicative of poor fisheries management and causing additional threats to endangered species. The Permanent Court of Arbitration accepted to hear the case under UNCLOS and environmental lawyers argued that these actions contravene UNCLOS treaty obligations. Arguments were also made that actions violating the UN Code of Conduct for Responsible Fisheries support the case according to obligations under UNCLOS. A decision on this arbitration, expected in the first half of 2016, will have far-reaching policy implications for environmental actions in disputed waters.

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A SPATIAL MANAGEMENT TOOL FOR SEAGRASSES IN THE GREAT BARRIER REEF WORLD HERITAGE AREA (Abstract ID: 27805)

The Great Barrier Reef (GBR) World Heritage Area includes one of the world's largest seagrass ecosystems (35 000 km2) with approximately 20% of the world's seagrass species. Key to understanding and managing this important ecosystem is reliable data on seagrass distribution, abundance and species composition, and how this changes through time. A range of mapping and monitoring programs since the 1980s have documented GBR seagrasses. These include GBR-wide coastal and seabed seagrass mapping through the 1980s and 1990s and a biodiversity mapping project in 2004; reef-top meadow mapping adjacent to shipping lanes as part of an oil spill response atlas in the remote northern GBR (2011-2014); and small-scale but long-term (>15 years) monitoring programs at coastal ports (e.g. Cairns and Gladstone). Until recently managers could not access the full range of seagrass spatial data in a format that included a range of scales, site and meadow information, nor could they interrogate the reliability of the dataset. We found, evaluated and incorporated over 300 seagrass spatial data sets collected from the GBR spanning 30 years into two publicly available GIS layers. We include information on seagrass presence/absence, percent cover, biomass, species present, dominant species, meadow area and survey date. This management tool allows seagrass information to be categorized depending on management questions regarding development, zoning, and planning, and is available for resource managers to model connectivity, better understand seagrass change, identify regions where seagrass information is deficient, and identify key seagrass areas for dugong and turtles.

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COMPETITIVE STRATEGIES OF THE CORALLIMORPH *RHODACTIS HOWESII*: ALLELOPATHIC EFFECTS ON CORAL MICROBIOMES AT PALMYRA ATOLL (Abstract ID: 29866)

Phase shifts from coral to algal dominance have become increasingly common on coral reefs around the globe, often in association with anthropogenic activities. However, alternative states can include other benthic organisms such as soft corals, sea anemones, sponges, or corallimorpharians, and are often associated with large-scale physical disturbances. Here, we focus on the invasion of *Rhodactis howesii* , a corallimorpharian on the coral reefs of Palmyra Atoll. Despite the apparent competitive dominance and demonstrated invasive potential of the corallimorph, little is known about the mechanisms involved in its spread across around the atoll. We used a laboratory experiment involving the exposure of the reef building coral *Acropora yongei* to corallimorph crude extract to investigate potential allelopathic effects of the extract on the coral microbiome. Exposure to the extract resulted in significant tissue loss and a decrease in photosynthetic efficiency of the corals. Samples were taken from degraded and healthy *Acropora* tissue for metagenomic analysis to look at shifts in the microbial communities present. This study represents an important initial step in determining what provides *Rhodactis howesii* with its competitive abilities and will help further our understanding of the invasion occurring at Palmyra Atoll.

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EFFECTS OF BLEACHING ON CORAL REPRODUCTION (Abstract ID: 28887)

Bleaching profoundly impacts coral reproduction often for years after an event. However detailed reproductive characteristics of coral post-bleaching have not been broadly described, especially as it relates to cryopreservation. Therefore, we measured a number of reproductive characteristics in coral in Kaneohe Bay in Hawaii in two species, Fungia scutaria and Montipora capitata during the bleaching period of 2014 and 2015. We examined and compared comprehensively with historical data: 1) spawning periods; 2) egg morphometry; 3) sperm concentration; 4) fresh and cryopreserved sperm motility exposed to differing concentrations of dimethyl sulfoxide; 5) time of first cleavage; 6) larval survival with fresh and cryopreserved sperm; 7) infection success; and 8) settlement success. Virtually all parameters of reproduction were reduced due to warming and bleaching stress. Because of this, we were interested in how cryo-stress might affect fertilization success and the time of first cleavage. In stressed fresh eggs and sperm, the addition of dimethyl sulfoxide altered the time of first cleavage. Moreover, once sperm was cryopreserved, this resulted in a steep decline in post-thaw viability and prevented any substantive further use in reproduction for conservation benefit. Worldwide as bleaching events become more frequent, the ability to bank and conserve coral ex situ will become significantly reduced. Thus, it is imperative that while genetic diversity is still high in these populations that intensive efforts are made to bank coral species during non-bleaching periods.

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IDENTIFYING SOURCES OF RESILIENCE IN CORAL COMMUNITIES USING A SPATIAL AGENT-BASED MODEL (Abstract ID: 28449)

Identifying attributes of coral reefs that confer resilience in the face of multiple stressors is a pressing challenge, but one that is logistically difficult to meet. By facilitating simultaneous manipulation of processes and attributes that would otherwise be too numerous or unwieldy to explore experimentally, agent-based models (ABMs) provide one valuable approach. Here we describe a spatially explicit, 2-dimensional ABM designed to elucidate if and how functional diversity (FD) within coral reef communities moderates resilience in response to multiple stressors. Each grid cell of the ABM covers 1 cm2 of a reef benthic community, and can represent part of a coral colony, a patch of algae, or a portion of barren ground. Agents can change their state through time in response to the following processes: spatial competition, erosion, grazing, and larval settlement, the latter moderating connectivity. Initial FD of communities varies among iterations, is derived from trait information gleaned from the literature, and is quantified in terms of the volume and dispersion that it exhibits in multi-dimensional trait space. Cyclones and bleaching events are imposed in the simulation, and the response of communities is measured in terms of resistance, recovery and capacity to retain identity of the community. We believe that this bottom up modelling approach can contribute to our understanding of the theoretical relationship between resilience, FD, and connectivity in coral reef ecosystems, and can also inform ongoing research and management efforts.

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BACTERIAL COMMUNITY PROFILING OF CORAL SPECIES ACROSS A BLEACHING EVENT (Abstract ID: 28791)

The functional importance of microbial communities associated with eukaryotes is increasingly recognized in many fields. The reef-building coral holobiont is notably diverse with microbes occupying roles everywhere from intimate endosymbionts to transients associated with external mucus layers. While the complexity is great and the full architecture of associations is not known, microbial communities are highly dependent on geographic location, host species, and environmental conditions. Recently, microbial communities have been suggested as playing an important role in coral bleaching. Recognizing the likely importance of the microbial dimension to understanding and predicting the response and resilience of corals to thermal stress, we surveyed Acropora hyacinthus, A. gemmifera, Porites cylindrica, and Pocillopora damicornis before, during, and after a significant natural bleaching event in 2015 in American Samoa. Although prior to the bleaching event samples had not been collected with microbial profiling in mind, we developed methodology to extract microbial DNA from our archived samples. We used 16S rDNA amplicons coupled with multiplex barcoding and paired-end 300bp sequencing on the Illumina MiSeq platform to survey hundreds of individual samples per species cost-effectively. Increased sample size and the ability to use archived samples in microbial surveys significantly adds to experimental power in the search for microbial correlates of coral heat resilience. We discuss the results of our particular survey as well as general considerations for undertaking similar metagenomic work.

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PERIODICALLY-HARVESTED CLOSURES EMERGE AS OPTIMAL MANAGEMENT STRATEGIES WHEN FISH BEHAVIOR IS CONSIDERED (Abstract ID: 29225)

Periodically-harvested closures (PHCs) are a form of community-based fisheries management often implemented within customary fishing grounds throughout the Pacific. Communities, and their co-management partners that advocate the use of PHCs, have broad objectives of fishery sustainability and conservation. However, PHCs are designed more specifically to increase harvest efficiency, and for occasional exploitation of protected stocks to support local social events. Despite their prevalence, the effectiveness of PHCs for simultaneously achieving these objectives remains uncertain. To assess PHC fishery outcomes, we developed a bioeconomic fisheries model that included fish behavior, and quantified how PHC open-closed schedule affects harvest efficiency (catch-per-unit-effort), biomass conservation and sustainable fishery yield. We also compared PHC effects with the effects of non-spatial and no-take marine reserve harvest regulations – forms of conventional management often heralded as optimal in well-managed and over-fished systems, respectively. Optimal PHC design was sensitive to overharvesting; regardless PHCs were more effective at achieving the multiple objectives than either conventional method. Key to the results is the fishers' ability to reduce fish wariness and increase catchability in PHCs targeting finfish using strategic harvest schedules. These findings challenge the dogma that PHCs are simply a cultural legacy to be accommodated by contemporary fisheries science, and instead place PHCs center stage as a potentially optimal fisheries management strategies.

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EFFECT OF MULTIPLE AND SYNERGISTIC STRESSES ON CORALS AT MICRO/NANO SCALE (Abstract ID: 28613)

Global environmental changes are recently occurring faster than any other time. The resulting combinations of natural and anthropogenic disturbances are strongly affecting coral reef communities. Coral damage can be caused both by abiotic factors (temperature, nutrients inputs, etc) and biotic factors (overgrowth of algae, diseases). These factors acting mostly in synergy had resulted in world-wide coral reef deterioration. Coral bleaching is the most impacting process that is affecting coral survival under elevated sea surface temperature and high irradiance scenario. Bleaching is well known to occur around the world; however its mechanism is not well understood. This is due to the high complexity of the "coral holobiont" (coral in symbiosis with its zooxanthellae and a microbial community that is maintain a delicate balance to keep the coral healthy. A novel point of view of bleaching mechanism using micro/nano size scales will be presented: 1) Study of pigments during thermal induced bleaching revealed that bleaching is a detoxification strategy to avoid oxidative stress; 2) Synergistic action of thermal stress with pathogenic bacteria exacerbates bleaching process and 3) Synergistic effect of thermal stress in a nitrate enriched environment can impede the recovery of corals after a bleaching event, turning the corals to be more susceptible to other environmental or anthropogenic stressors. This scientific approach to study the effects of multiple stresses at micro/nano scales revealed the importance of organisms' adaptations within certain thresholds

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CHARACTERIZING THE GROUPER FISHERIES AND STOCKS IN SELECTED MUNICIPALITIES OF THE PHILIPPINES (Abstract ID: 29051)

Groupers are found all over the Philippines but are prone to population decline and extirpation due to high fishing pressure and lack of effective fisheries regulations throughout the country. This study provides an overview on grouper fisheries and standing stock in at least ten municipalities in the Philippines. Data from fisheries assessments using focus group discussions and semi-structured interviews and from underwater fish visual census were used in the analyses. Results show that municipalities with intense and unregulated grouper fisheries (i.e. Anda, Bolinao, Lian, Governor Generoso, Bais, Cabugao and Santiago) have low grouper densities (0.25-3 ind/500m2.), low biomass (6.82-137 g/500m2), and an assemblage dominated by few, small-sized and least-valued species only. In contrast, municipalities with functional and effective fisheries management interventions (e.g. gear restrictions, marine protected areas) that attenuate the effects of fishing, such as in Taytay and Sablayan, have higher densities (4-6 ind/500m2) and biomass (223-486 g/500m2), and with large or highly valued species still present in their coral reefs. In the case of Samal Island, high grouper density (5.56 ind/500m2) yields a relatively low biomass (78 g/500m2) due to the fact that most of the observed fishes were juveniles, suggesting that adults might be overfished. This study provides a list of areas that need prompt action to remediate further stock collapse and identifies critical grouper species that should be prioritized for conservation.

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RESOURCE COMPETITION AND PREDATION RISK DIFFERENTIALLY AFFECT PARROTFISH FORAGING BEHAVIORS (Abstract ID: 28442)

Parrotfishes interact with coral reefs in many important ways. They consume algae that compete with coral for space on the benthos and facilitate coral settlement by scraping bare spaces on the reef. It has been demonstrated that the spatial patterning of herbivore foraging may be an important determinant in the trajectory of coral reef benthic state. In

order to evaluate the relative importance of food resource abundance, competition, and predation risk on structuring parrotfish foraging behavior, we conducted a comparative study at two islands that are subject to drastically different management regimes. One of the islands (Palmyra Atoll) is pristine and unfished with high biomass of herbivores and predators while at the other (Mo'orea, French Polynesia) both trophic groups are fished. Our results indicate that both predation risk and competition for resources play a role in structuring foraging behaviors in Bullethead parrotfish (*Chlorurus sordidus* ), but they act of different aspects of foraging. Bite rates were affected primarily by direct interference competition and chronic level of predation risk, measured by predator abundance. However, predator abundance had no effect on space use which was related to levels of exploitative competition from other herbivores in the community, particularly large-bodied parrotfishes. Because herbivore and piscivore populations are sometimes independently managed on coral reefs, it is important to understand how interactions among these trophic groups affect a suite of behaviors related to herbivory.

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A TEST OF TROPHIC CASCADE THEORY: FISH AND BENTHIC ASSEMBLAGES ACROSS A PREDATOR DENSITY GRADIENT (Abstract ID: 27990)

Removal of predators is often theorized to alter community structure through trophic cascades. However, evidence is often circumstantial on coral reefs because fishing pressure frequently co-varies with other anthropogenic effects. Australia's Great Barrier Reef (GBR) has experienced fishing-induced declines of apex predators and mesopredators, but fishers do not target herbivorous fishes and pollution is minimal on the outer GBR; thus, the GBR provides an ideal system to investigate trophic cascade theory. Here, I quantify fish and benthic assemblages across a fishing-induced predator density gradient on the GBR, including apex predators and mesopredators to herbivorous fishes and benthic assemblages, to test for evidence of trophic cascades. Using a structural equation model, I found no cascading effects from apex predators to lower trophic levels: a loss of apex predators did not lead to higher levels of mesopredators, and this did not suppress mobile herbivores and drive algal proliferation. Likewise, I found no effects of mesopredators on lower trophic levels: a decline of mesopredators was not associated with higher abundances of algae-farming damselfishes and algae-dominated reefs. These findings indicate that top-down forces on coral reefs are weak, and densities of most community members are regulated by indirect factors that vary through space, such as regional effects, stochastic disturbances, trophic versatility, and system openness. We conclude that predator-mediated trophic cascades are probably the exception rather than the rule in this complex ecosystem.

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DECLINE IN ABUNDANCE AND HEALTH STATE OF AN ATLANTIC SUBTROPICAL GORGONIAN POPULATION (Abstract ID: 29560)

Losses in coral cover have been widely reported for the Caribbean. In contrast, much less is known about the health state of the Brazilian reef fauna, which was declared as a priority for Atlantic biodiversity conservation due to its high degree of endemism. In the present study we assessed the general health state of *Phyllogorgia dilatata* assemblages at the subtropical reefs of Arraial do Cabo (southeastern Brazil), where observations suggest that the abundance of this endemic gorgonian species has declined. We found that about 49% of the sampled colonies were dead, and 73% of the living colonies were affected by tissue loss. Tissue loss initially manifested as multifocal holes in the planar colonial coenenchyme and peripheral tissue retraction leaving denuded skeletal axes. In combination with other recent studies, our results raise the awareness for an increasingly threatened Southwestern Atlantic reef coral fauna.

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IMPACT OF OCEAN WARMING ON CENTURY-SCALE GROWTH TRENDS OF INSHORE AND OFFSHORE CORALS THROUGOUT THE WESTERN CARIBBEAN SEA (Abstract ID: 29535)

Anthropogenic elevation of atmospheric carbon dioxide continues to cause global ocean temperatures to increase. Although this rise in ocean temperature has generally reduced rates of coral growth worldwide, considerable variability in corals' growth response to thermal stress exists across the reefscape. Previous studies suggest that corals exposed to historically greater baseline diurnal and seasonal fluctuations in temperature are better able to cope with future anthropogenic thermal stress. We investigated the relationship between historical sea surface temperatures and annual skeletal growth parameters (skeletal density, skeletal extension, calcification rate) of *Siderastrea siderea* and*Pseudodiploria strigosa*–two abundant, widespread, and long-lived massive scleractinian corals–across three different reef systems spanning 2000-km of the western Caribbean Sea. Over 240 coral cores were extracted from paired inshore-offshore localities of the Florida Keys Reef Tract, Belize Barrier Reef System, and Panama's Bocas Del Toro Reef Complex and then scanned for density using computer tomography. Our results indicate considerable variability in coral growth response to warming both between and within the three reef systems, with a colony's specific growth response to recent anthropogenic warming being closely linked to its baseline environmental history. Results provide one of the most comprehensive overviews of coral growth response to past ocean warming and offer insights into how corals are likely to respond to predicted future changes in ocean temperature.
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DYNAMICS OF CARBONATE PRODUCTION OF HALIMEDA ON SHALLOW CORAL REEFS (Abstract ID: 28428)

The calcifying alga Halimeda contributes significantly to the production of carbonate sediments. Carbonate production by Halimeda is driven by primary productivity, calcification and herbivory, yet the relative importance of these processes is unclear. Understanding Halimeda dynamics is critical to make plausible predictions about their contribution to reef carbonate budgets. For example, Halimeda is often flourishing within the complex structure of branching acroporids which offer protection from herbivory but how coral habitats affect Halimeda carbonate production is unknown. This is important because these corals are highly susceptible to climate change. To answer this question we developed an individual-based model of Halimeda population dynamics by incorporating rates of recruitment, segment growth, herbivory and other sources of mortality. The model was parameterized with seasonal demographic rates estimated using fish-exclusion cages in Heron Island, Australia, and successfully predicted the observed biomass of Halimeda both inside and outside Acropora habitats. Carbonate production peaked in summer with Halimeda productivity being enhanced by temperature. Because carbonate production was higher inside Acropora habitats in summer, high temperature in the future may increase Halimeda production of carbonate sediments. However, this outcome may be altered by future losses of Acropora habitats due to thermal stress. As fish herbivores may also be affected by a loss of structural complexity, predicting the future of Halimeda carbonate dynamics is uncertain.

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HISTORIC STEPS TAKEN BY CUBA AND THE U.S. TO COLLABORATE ON MARINE PROTECTED AREAS (Abstract ID: 28184)

On Nov 18, 2015, the U.S. signed a memorandum of understanding (MOU) with Cuba's Ministry of Science, Technology and Environment to cooperate on the conservation and management of Marine Protected Areas – one of the first official bilateral agreements following the recent renewal of diplomatic relations between the U.S. and Cuba. The MOU is the basis for a working relationship between NOAA's Office of National Marine Sanctuaries and Cuba's National Center for Protected Areas (CNAP) and includes sister sanctuary relationships between Flower Garden Banks and Florida Keys National Marine Sanctuaries and Guanahacabibes National Park and Banco de San Antonio at the western

tip of Cuba. The National Park Service is also part of the MOU and links Dry Tortugas and Biscayne National Parks in the sister relationships. This achievement follows years of work by many individuals and organizations to bring together marine scientists, resource users and managers in both countries to develop joint conservation strategies for the marine ecosystem of the region. The goal of this collaboration is to understand, enhance, and protect the connections between the coral reefs of Cuba and the U.S. and address shared conservation challenges in the marine protected areas of the two countries. The signing of the MOU lays the foundation to build important cooperative programs to support marine science, management, and education efforts in both countries.

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BIOECONOMIC EVALUATION OF MARINE RESERVE SIZE: PROTECTING RESTORED CORAL REEFS WHILE MAXIMIZING FISHERY VALUE (Abstract ID: 28457 | Poster ID: 266)

The cost of coral propagation and restoration coupled with limited funding make cost-effective measures to protect restored reefs and maximize program ROI critical. Marine reserves can be effective in protecting reefs and enhancing fishery value, however, determining optimal reserve size to accomplish both objectives is challenging. A framework for evaluating the costs and direct economic value of marine reserves protecting restored reefs can inform decisions related to marine resource policy and management. This study will develop a conceptual model for determining the optimal size (maximizing the present value of net fishery revenues) of no-take marine reserves protecting local coral reef restoration efforts and inform a broader examination of the Total Economic Value and ROI of active reef restoration in the Caribbean. The present value of the fishery will be evaluated for reserves of varying size, subject to outplanted coral population dynamics and diffusion of fish from the reserve to fishing grounds. Demographic data from outplanted corals will be used to generate preliminary empirical estimates of fish population levels, harvest and fishery value. The results of this study may inform efforts to determine the optimal size of reserves for the protection of restored coral reefs as well improve the understanding of the economic value of active reef restoration. Whether, and under what conditions, a clear "business" case can be made for reserves to protect restored reefs will be useful for a variety of audiences and may aid in prioritization of management actions.

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MPA PERFORMANCE UNDER PRESSURE: CAN THEY YIELD DISTURBANCE REFUGES AND ENHANCE RECOVERY? (Abstract ID: 28972)

No-take marine reserves are key tools for biodiversity conservation, yet their role in enhancing resistance and recovery from disturbance remains equivocal. Coral reefs of the Keppel Islands, Great Barrier Reef (GBR), have been heavily impacted by climatic disturbances (coral bleaching, floods and a cyclone) over the past decade. We monitored fish and coral communities throughout this period, on no-take reserve and fished reefs. We found high coral mortality from bleaching in 2006 and the major floods in 2011 and 2013. The highest levels of live hard coral cover were recorded in 2004 (65%) and in 2009 (61%); 2013 was the lowest ebb in reef condition (heavy losses of corals and fishes). In 2015, several reefs provided key refuges for coral (predominantly Acropora spp.), with 50%+ cover. The abundance of the primary fishery target species on the GBR, coral trout (Plectropomus spp.) is highly dynamic and correlated with the cover of live hard coral cover, habitat structural complexity and prey abundance. Reserve reefs have supported higher abundances of larger coral trout than reefs that are open to fishing throughout the survey period, except when reef condition was at its worst in 2013. The loss of corals, structure and prey eroded the benefits of the no-take zones, but the rate of recovery between 2013 and 2015 was significantly greater in reserves than on fished reefs. While coral refuges are independent of protection, reserves that resist disturbance can provide important refuges that may enhance recovery of community structure, productivity and fishery target species.

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WEST MAUI COMMUNITY-BASED STREAM RESTORATION: SOLUTIONS TO PREVENT SEDIMENT FROM REACHING THE NEARSHORE ENVIRONMENT (Abstract ID: 29163 | Poster ID: 439)

Sediment from stream inputs represents a major source of land-based pollution that is negatively affecting coral reefs around the world. Successful solutions to this problem will include community ownership and buy-in, sustainable stewardship, and incorporation of cultural values and practices. In West Maui, recent studies conducted of perennial streams found that approximately 40% and 55% of the banks of Ka'Opala and Papua streams respectively consist of actively eroding fine-grained sediment. During rain events, this sediment becomes suspended, and is transferred to the nearshore environment via stream channels. This creates plumes of turbid water along the coastline, which negatively impact coastal water quality and coral reefs. Modern adaptation and implementation of traditional Hawaiian land management practices will help to solve this problem. The Coral Reef Alliance is leading a knowledge sharing group consisting of local and regional experts and restoration practitioners who will together identify solutions that integrate traditional Hawaiian practices such as lo'i kalo (wetland taro cultivation) into a modern management system. In this talk, we will present the preliminary findings of the knowledge sharing group with the goal of informing similar efforts underway in other geographies.

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ATTENUATION OF WHITE BAND DISEASE TRANSMISSION IN*ACROPORA CERVICORNIS* BY A QUORUM SENSING INHIBITOR (Abstract ID: 28059)

Among the greatest threats to global coral reef health are coral epizootics, which are increasing in frequency and severity. In particular, white band disease (WBD) has devastated Caribbean acroporid populations since its initial outbreak in 1979. However, despite its widespread and devastating effects, the etiology of WBD remains largely uncharacterized. Here we examine the role of quorum sensing (QS) within bacterial communities associated with WBD-infected *A. cervicornis*. QS refers to the phenomenon in which bacterial gene expression is regulated in response to changes in population density. This is accomplished through the secretion and detection of signaling molecules called autoinducers. Microbial communities isolated from WBD-infected *A. cervicornis* were exposed to QS inhibitor (an autoinducer antagonist) and then dosed onto healthy test corals. WBD-associated bacteria supplemented with QS inhibitor lost the ability to transmit disease whereas all *A. cervicornis* exposed to uninhibited (i.e. control) WBD bacterial communities became infected within two days. In order to determine the species influenced by the addition of QS inhibitor, bacterial samples were taken from each test coral at three time points: (T0) pre-dosing (T1) post-dosing at 12 hours and (T2) post-dosing at 24 hours (after WBD symptoms appeared in control corals). Microbial 16S V3-V4 rRNA metagenomic sequencing and multivariate analyses were then used to identify shifts in the bacterial communities between QS-inhibited and uninhibited WBD-associated bacterial communities.

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SEXUAL AND ASEXUAL RECRUITMENT OF POCILLOPORID CORALS ON AN EQUATORIAL EASTERN PACIFIC REEF FLAT (Abstract ID: 28943 | Poster ID: 201)

Coral recruitment, the addition of new colonies to a population, can result from either sexual reproduction via larval settlement or through asexual reproduction via fragmentation. We studied the patterns of temporal variation in the number of recruits of sexual and asexual origin in a community of species of Pocillopora on a reef flat at Gorgona Island, Colombia. To estimate rates of recruitment and mortality, we periodically followed recruits during ten months between November 2012 and September 2013 on ten permanent belt transects (10 x 2 m). Recruitment peaks were observed in June 2013 for both sexually and asexually-produced recruits, with 0.08 ± 0.07 and 0.76 ± 0.48 colonies m-2 mo-1, respectively. However, recruitment was spatially variable and temporal variation was significant only for the rate of asexual recruitment. Mortality of recruits increased significantly towards the end of the study, but temporal variation in mortality was significant only for sexually-derived recruits. The balance between recruitment and mortality of juveniles indicates that in this community Pocilloporids can maintain themselves through either sexual or asexual recruitment. However, 91.3% of total recruitment was asexually-produced supporting the notion that pocilloporid reefs in the eastern Pacific are maintained mainly by asexual reproduction and are, therefore, more vulnerable to global change than reefs elsewhere.

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LABORATORY TEMPERATURE SELECTION IN SYMBIODINIUM CAN ENHANCE CORAL THERMAL RESILIENCE (Abstract ID: 28516)

Temperature increases of only 1 °C above summer maxima can cause coral bleaching. This breakdown in the endosymbiosis between coral and their Symbiodinium can cause considerable coral mortality. As coral bleaching tolerance is dependent on their symbionts, the human-assisted acceleration of evolutionary processes in Symbiodinium has been proposed as a strategy to enhance coral thermal resilience. We report an adaptive response in cultured Symbiodinium after only ~150 generations of thermal selection at 31 °C, a 4°C increase from the control temperature; the 31°C selected Symbiodinium outperformed the wild-type at 31°C, with higher growth rates, photosynthetic performance and lower extracellular reactive oxygen species production. At ambient temperature the performance of the selected-type was similar to that of the wild-type across most traits, indicating limited costs of thermal selection. Coral recruits of three Acropora species were subsequently inoculated at 27°C with both the selected and wild-type symbionts. Once symbiosis had established, a proportion of each was moved into 31°C. We observed species-specific differences in performance under elevated temperature. At 31°C, recruits harbouring the selected-type symbionts bleached slower than those infected with the wild-type cells, had greater photosynthetic capacities and exhibited similar growth to recruits harbouring selected and wild type symbionts at 27°C. Inoculation of corals with laboratory selected Symbiodinium may provide a highly valuable approach to enhance coral fitness in our warming oceans.

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LARVAL PERFORMANCE OF A CARIBBEAN BROODING CORAL UNDER HEAT STRESS DEPENDS ON THE THERMAL CONDITIONS EXPERIENCED BY THEIR ANCESTORS (Abstract ID: 30009)

Global warming causes increased physiological stress to corals worldwide, yet many coral populations survive well above their optimal temperature range. Recent studies have identified key physiological pathways that allow these corals to cope with heat stress. It is however not fully understood how these traits emerge in a population: through short-term acclimatization, or long-term local adaptation? We investigated how heat tolerance traits in a Favia fragum population are passed on from parental colonies to their offspring. This species grows at the warm-water outflow of a desalination plant on Curaçao, where temperature greatly fluctuates daily and frequently exceeds 31°C. In an ex-situ reciprocal transplant experiment, we compared survival, settlement, and photosynthetic efficiency of larvae brooded by colonies from the warm outflow site to that of larvae from a nearby ambient reef. When exposed to heat stress for 5 days, larvae from the warm site survived 40% better and settled 5 times more than those from the ambient site. The latter suffered a 15% reduction of maximum quantum yield compared to larvae from the warm site. We conclude that parents that grow in warmer habitats transmitted key heat resistance traits to their offspring. Preliminary population structure analysis supports adaptation as the primary mechanism for heat tolerance. We hypothesize that in 60-years operation of the desalination plant, the rapid generation time of F. fragum caused natural selection over several generations that allowed these corals to acquire heritable traits for heat tolerance.

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CONTRASTING ABUNDANCE OF JUVENILE CORALS AT TWO NATIONAL PARKS IN THE ANDAMAN SEA (Abstract ID: 29363 | Poster ID: 664)

Understanding the patterns and relationship of coral larval supply and juveniles are crucial in enhancing reef biodiversity, recovery and resilience in response to disturbances. The objective of this study is to compare diversity and abundance of juvenile coral colonies on natural substrates and recovery trends in Mu Ko Surin and Mu Ko Phi Phi in the Andaman Sea. Results showed that highest density of coral recruits was found at Ao Suthep (Mu Ko Surin) while lowest density was at Ao Loh Samah (Mu Ko Phi Phi). Among study sites, Ao Suthep had the most diverse coral (at the genus level) while Ao Loh Samah had the least. Generally, *Fungia* was the dominant coral recruit at Mu Ko Surin while *Porites* was the dominant juvenile coral at Mu Ko Phi Phi. Species composition of coral recruits was significantly different between Mu Ko Surin and Mu Ko Phi Phi. Coral recruits and percentages of live coral cover were positively correlate ($r=0.25$, $p<0.01$) in all sites. This suggests that coral recovery following the bleaching events at Mu Ko Phi Phi would require a longer period of time.

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VARIATION IN GENOTYPIC DIVERSITY OF THE THREATENED PILLAR CORAL, DENDROGYRA CYLINDRUS, AND ITS ALGAL SYMBIONT IN FLORIDA, CURACAO, AND THE US VIRGIN ISLANDS (Abstract ID: 28939 | Poster ID: 186)

The threatened pillar coral, Dendrogyra cylindrus, is the only species in its genus, and thus its extinction would mean the extinction of a genus. Comprehensive surveys of Caribbean reefs over the past 30 years failed to find any pillar coral recruits, mobilizing efforts for active management of this unique species. Prior to nursery rearing and outplanting of fragments, the population genetics of the host and its specific symbiotic algal species (Symbiodinium 'dendrogyrum') must be evaluated. Eleven microsatellite markers were developed de novo for D. cylindrus and nine existing microsatellites markers were applied to S. 'dendrogyrum'. Coral colonies from sites along the Florida Reef Tract, Curacao, and the US Virgin Islands were genotyped using these markers. Results indicate that D. cylindrus is highly clonal in Florida, with dense patches containing just one host genotype. Host populations in Curacao, however, appear to be more diverse and were highly differentiated from Florida populations. The genotypic diversity of S. 'dendrogyrum' is lower than its host, with identical clones often occupying multiple reefs. While D. cylindrus is known as a gonochoric broadcast spawner, observations revealed that pillars of identical genotype released gametes of the opposite sex, indicating that D. cylindrus might be a hermaphrodite capable of geitonogamy. The low genotypic diversity of host and symbiont and apparent strong host population differentiation in D. cylindrus make it imperative that diverse genotypes are incorporated into local restoration efforts throughout the Caribbean.

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THE NEED FOR AN EX-SITU CORAL RESTORATION NURSERY IN HAWAII (Abstract ID: 28210)

Hawaii has both large commercial harbors and military ports. The reefs proximate to these harbors have a higher chance of incurring damage due to large vessel groundings, spills, dredging activities, and harbor modifications. In addition, there are many small recreational boat harbors around the Main Hawaiian Islands where associated damage from small boat groundings and anchor damage is common. Given the extremely low natural recovery rates for coral in Hawaii, there is a strong need to mitigate for these damages. The Hawaii Division of Aquatic Resources has established the first ex-situ Coral Nursery in Hawaii, with the broad goal of addressing the mitigation challenges accompanying modern harbor-associated anthropogenic impacts. The DAR Coral Nursery represents an opportunity to test a variety of concepts toward innovative coral reef restoration and mitigation, including preservation of rare and threatened coral species in a coral "ark", asexual planulation for mitigation, and a fast-growth protocol for reaching size refuge targets.

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ASSISTED EVOLUTION VIA HYBRIDIZATION: A NEW APPROACH IN CORAL REEF CONSERVATION (Abstract ID: 28272)

The world's coral reefs are facing unprecedented changes in temperature and carbonate chemistry. This rate of change can surpass the ability of many organisms to acclimatize or adapt to survive. Here we assess the value of assisted evolution via hybridization as one possible way of accelerating evolutionary processes to assist corals to survive current climate change. Hybridization may create novel recombinant genotypes, providing

a wider array of variation for natural selection to act upon compared to purebred organisms alone. Colonies of four *Acropora* species were collected in the Central Great Barrier Reef and were experimentally crossed in Dec 2015. Fertilization rates were high (>90%) in purebred and hybrid crosses of both directions in *Acropora tenuis* x *Acropora loripes*, as well as *Acropora florida* x*Acropora sarmentosa*. Rates of embryonic development were assessed for each cross at 3, 9, 15, 21, 33, 45, 57, 69, and 93 hours after fertilization. Rates of*Symbiodinium* uptake, growth, survival and photosynthetic performance under ambient condition (27.5°C, 415ppm) and mid-century condition (28.5 °C, 685ppm, RCP8.5) in purebreds and hybrids of the two crosses will be discussed. This project will assess whether interspecific hybridization can be used as a novel approach for enhancing coral reef restoration initiatives in a changing climate.

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ENHANCING HERBIVORE ASSEMBLAGES BARRICADE FURTHER DEGRADATION OF LINGERING CORAL REEFS IN GULF OF KACHCHH, INDIA (Abstract ID: 29245 | Poster ID: 302)

Despite being at the northern most margins of coral reef distribution in the Indian Ocean, experiencing arid climate, transgressed sea level due to the past tectonic up-liftment, high sedimentation, semi-diurnal tidal fluctuation, coral exploitation and industrialization, Gulf of Kachchh still preserves some most temperature tolerant and wide adapted residual coral population. These degraded and poor resilient reefs are also affront with the indiscriminate macro algae growth and exploitation of herbivore fishes at their juvenile stage. Herbivores play a critical role in coral reef resilience by limiting the establishment and growth of algal communities that impede coral recruitment. Present study quantified the status and seasonal variation of herbivors assemblage on the natural reefs and artificial coral restoration structures in 3 spatially distinct sites along the Gulf. Density of Trochus spp. observed high during post monsoon on both natural reefs and artificial structures (5.04±0.69/m2and 5.38±0.76/m2 respectively). Sea urchin density was found very low throughout the study period (maximum of 0.77±0.09/m2 during post monsoon). Although density and abundance of herbivore grazers and detrivores fishes were found assembled conspicuously in and around the artificial coral restoration structures, it is inadequate for the whole reefs. Managing exploitation and restoration of herbivory are also an urgent priority to improve the resilience and recovery of the Gulf. Strategies for improving the herbivores of the reefs are discussed.

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GENETIC VARIATION IN POPULATIONS OF A TROPICAL MYSID, MYSIDIUM GRACILE (Abstract ID: 30093 | Poster ID: 31)

The swarm-forming mysid Mysidium gracile aggregates near coral reefs and are important components of reef ecosystems. Occupying an intermediate level of marine food webs, they transfer energy and nutrients from planktonic species to reef fishes. However little is known about the genetic composition of swarms, connectivity of populations, and thus overall regional levels of genetic diversity. Here we assessed genetic variation within and among swarms occurring near seven Caribbean islands. The COI gene was amplified and sequenced for 121 mysids representing 17 swarms. Haplotype diversity was determined using DnaSP5.0. Twenty-four haplotypes were detected with a haplotype diversity of 0.93, thus indicating a high level of haplotypic variation. Bayesian phylogenetic reconstruction showed 7 distinct clades. Mysids from San Salvador (Bahamas), Frederiksted (USVI), Culebra (Puerto Rico), St. Thomas (USVI) each formed unique, well-supported clades as did a subset of individuals from St. John (USVI). An additional clade was composed of individuals from Guanica (Puerto Rico), Bigelow Guana (BVI) and some individuals from St. John (USVI). The final clade included individuals from St. John (USVI) and White Bay Reef Guana (BVI). Overall, these results show that there is substantial genetic variation among mysid populations and that some genotypes are shared across the region. This variation may become important as reef conditions changes in response to changes in climate.

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UNDER PRESSURE – HOW SEED BANKS PROVIDE A FUNCTIONAL CLUE INTO DEEPWATER SEAGRASS SUCCESS (Abstract ID: 28881 | Poster ID: 514)

As a functional group seagrasses are ubiquitous throughout the Great Barrier Reef World Heritage Area (GBRWHA), from offshore coral reefs to inshore estuaries and embayments. Mounting concern for acute and chronic anthropogenic pressures on seagrasses have steered efforts to develop indicators of light attenuation stress. Developing a "one-size-fits-all" model for the 15 species found in the GBRWHA is ineffective without accounting for functional differences in their life history traits. We investigated the growth attributes and adaptation of deepwater (>10m) seagrass communities with a goal to improve coastal management strategies impacting this functional group. We explored what role density and stratification of a seed bank plays in meadow resilience, and how the optical challenges of growing at depth may affect seed germination in these ephemeral meadows. Sediment cores were collected over three years from three *Halophila* spp. meadows within the GBRWHA. Seed densities varied over time and with depth (≤ 10cm) but followed similar trends among meadows. Collections of mature fruits afforded fresh seeds to establish the first successful seed viability test known for this genus. Fresh seeds were also used to examine the role spectrally-refined light at depth has on germination success. While strategically *Halophila* spp. are known to rely on seeds, having a more intimate understanding of the functionality of their seed banks and how they respond to environmental cues, bridges a science gap for effectively mitigating light-driven loss of tropical deepwater seagrasses.

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CAN FISH HELP CORALS DURING BLEACHING EVENTS? (Abstract ID: 28520 | Poster ID: 345)

Global environmental change is likely to have profound influence on how marine symbioses operate, thus impacting nutrient cycling, ecosystem function, and evolutionary processes. On coral reefs, fish living within the branches of coral colonies can promote coral growth and it has been hypothesized that the enhanced water flow and nutrients provided by fish could ameliorate coral bleaching. The aim of this study was to evaluate the influence of small schooling damselfish on the health of their host corals during and after a thermal bleaching event. Using a controlled laboratory experiment this study demonstrates that corals inhabited by fish have higher photosynthetic efficiency in both control and heated treatments and that elevated temperatures caused higher mortality and a larger decline in photosynthetic efficiency in corals that did not have fish present. Thus, our experiment provides the first experimental evidence that fish living within coral colonies can affect coral susceptibility to thermal bleaching. Understanding how interactions between species, such as fish-coral mutualisms, can moderate the effects of changing environmental conditions is critically important for understanding the effects of climate change on reef organisms and coral reef management.

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IMPROVING CORAL PROPAGATIONS IN THE HATCHERY THROUGH FEEDING AND LIGHT CONTROLS BEFORE TRANPLANTATION TO NATURAL REEFS (Abstract ID: 30075)

Mass culture of corals using sexual propagation technique was successfully developed in Thailand. The fertilization rates of gametes ranged between 92-97%. After fertilization in the hatchery, the juvenile corals were then reared in a land-based rearing system for at least 2 years before they were transplanted back to natural reefs. The survival rate of juvenile corals after transplantation into the reefs was more than 50%. At present, 5 year-old post-settlement colonies were detected to be reproductively mature and subsequently spawned every year since 2013. However, since juvenile corals propagated from sexual reproduction needed to be raised in the hatchery for at least 2 years before transplantation, the maintenance cost were high; more than 100 USD per 1 juvenile colony. Thus, feeding and light control experiments were conducted to determine whether adding those factors could enhance higher growth rates of juvenile corals in the hatchery. The results showed that when juvenile corals were fed by Artemia salina nauplii, and additional lights were added in the hatchery, the growth rates of juvenile corals increased significantly, twice as high as those without feeding and additional light. Therefore, feeding juvenile corals with supplementary food such as Artemia salina nauplii and additional light controls can be options for enhancing growth of juvenile corals in the captivity before transplanted to natural reefs. Detailed results will be showed and discussed.

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FROM CORAL TO "SPONGE REEFS"? EXCAVATING SPONGES AS INDICATORS OF CHANGE (Abstract ID: 28067)

Coral reef communities in the Caribbean and Florida have changed dramatically during the past three decades, shifting ecological phases or states. Although sponges provide habitats on reefs, destructive excavating sponges such as Cliona delitrix also compete and take over space from declining corals. To evaluate how much excavating sponges can take over coral reefs affected by climate change, we developed a Markov chain model based on field data obtained over a period of 10 years from 100 coral colonies in a high latitude coral reef in Florida, USA. The model takes a multi-taxa approach in which corals, sponges, and algae are included. Analysis of the ten-year data set showed an increase of C. delitrix in 2002 that was accentuated after the 2005 heat-stress related coral mass mortality event. Projections of the mean model and sensitivity analysis suggested that for the continuous survival of this coral reef, coral recruitment has to increase. When disturbance was added, macroalgae became the dominant final state on reefs in most projections. However, in case of consecutive, moderate coral mortality events, the excavating sponges could reach higher cover. Under a climate change scenario (i.e. heat stress), both corals and excavating sponges declined, although sponges at a slower rate. Success or decline of excavating sponges depended on the intensity of heat stress and coral mortality events that provided the sponge with substratum.

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A NOVEL FEMALE-SPECIFIC AND SEXUAL REPRODUCTION-ASSOCIATED DMRT GENE DISCOVERED IN THE STONY CORAL, EUPHYLLIA ANCORA (CNIDARIA, ANTHOZOA) (Abstract ID: 27920)

Transcription factors encoded by the Dmrt gene family regulate multiple aspects of animal reproduction. Most the studies investigating the Dmrt gene family were conducted in model organisms from bilateral species, with a particular emphasis on their role in male sex determination. It is still unclear whether the Dmrt genes found in basal metazoans such as cnidarians, share similar characteristics with their orthologs in other metazoans. In this study, seven full Dmrt gene transcript sequences for a gonochoric coral, Euphyllia ancora, were obtained through transcriptome data mining, RT-PCR/RACE, and sequencing. These EaDmrts were subjected to quantitative assays measuring temportal and tissue-specific expression. The results demonstrate a unique gene expression pattern for EaDmrtE, which is enriched in female germ cells during the spawning season. Based on the phylogenetic analyses performed across the homologous Dmrt genes in metazoans, we found that the female-specific EaDmrtE is not related to Acropora coral DM1 nor vertebrates Dmrt1, which are involved in sexual reproduction, especially in sex determination (vertebrate Dmrt1). Additionally, high levels of EaDmrtE transcripts detected in the unfertilized mature eggs are retained in newly formed zygotes, but decrease during embryonic development. We suggest that the newly discovered gene might play a role in oogenesis and early embryogenesis as a maternal factor in corals. Therefore, the sexual reproduction-associated Dmrt gene(s) should have arisen in cnidarians and might have evolved multiple times in metazoans.

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ATTEMPTED GENETIC TRANSFORMATION OF *SYMBIODINIUM MICROADRIATICUM* USING VARIOUS TRANSFORMATION TECHNIQUES (Abstract ID: 28553 | Poster ID: 119)

The endosymbiotic interaction of *Symbiodinium* spp. with various marine invertebrates represents the basis of the entire shallow-water coral ecosystem. The specificity of this interaction can vary greatly depending on the specific *Symbiodinium* sub-species, invertebrate species and environmental conditions in question. One of the key advances that would greatly aid the elucidation of the molecular details of this interaction would be the establishment of a tractable genetic transformation system in a*Symbiodinium* species. A silicon carbide whiskers-based transformation technique was reported for *Symbiodinium microadriaticum* 18 years ago, and we have attempted to use this protocol for transformation of *Symbiodinium microadriaticum* strain CCMP 2467. In addition, we have attempted to use standard algal transformation techniques such as biolistics and electroporation as well as non-standard techniques such as FuGENE transfection. To date, we have been unable to introduce antibiotic resistance or GFP fluorescence under the control of the previously published p35S promoter or endogenous *Symbiodinium* promoters as genetic markers into our *Symbiodinium* cells. Whilst we have not attempted to test these techniques on other *Symbiodinium* strains, we propose that a new, radical transformation method may be required to introduce extracellular DNA in*Symbiodinium*.

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DNA-BARCODING REVEALS NICHE DIFFERENTIATION AMONG DIFFERENT GALAXAURACEAE SPECIES (RHODOPHYTA) IN THE DONGSHA ATOLL NATIONAL PARK, TAIWAN (Abstract ID: 27947)

Dongsha Atoll National Park is located in the most northern part of South China Sea and consists of three parts, namely the inner lagoon area, the reef rim area, and the outer reef area. Therefore, Dongsha Atoll National Park comprises various marine habitats, for example, the lagoon, seagrass bed, coral reef and sandy ground. The water is much calmer in the inner lagoon area that is sheltered by the reef rim area, but much more disturbed by waves in the outer reef area. Therefore, Dongsha Atoll National Park is a perfect area to examine how different types of habitats shape the distribution of marine organisms. To tackle this issue, we focus on common tropical / subtropical seaweeds, Galaxauraceae, and applied DNA-barcoding (rbcL gene) to assess the effects of various habitats on their distribution in the Dongsha Atoll National Park. From ten different sampling sites in the inner lagoon area and the outer reef area, we found four genera and nine galaxauraceous species in the Dongsha Atoll National Park. Overall, Dichotomaria marginata, D. obtusata and Galaxaura divaricata occurred more abundantly in calmer water area, whereas D. elegans, G. rugosa and Tricleocarpa occurred more frequently in wave-exposed area. These results allowed us to discuss how different types of habitats affect the distribution of seaweeds. Based on our research, we proposed that Galaxauraceae can be developed as a bioindicator to classify clam and wave-exposed habitats in tropical / subtropical coastal marine ecosystem.
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PARTNERING WITH PRIVATE TOURISM AND HOTEL DEVELOPMENT SECTORS TO INITIATE CORAL REEF RESTORATION IN CHINA (Abstract ID: 28257)

The Sanya region of Hainan Island, China, is an important tropical destination for the domestic tourism market, which relies heavily on coral reef-related coastal activities. The coral community in the Sanya region has suffered a dramatic decline due to increasing threats, including coastal development, eutrophication, overfishing, destructive fishing and coral mining, along with overloaded, irresponsible diving activities. The Nature Conservancy (TNC) China Program has recently started the first coral reef restoration project in Sunny Bay and Baifu Bay of Sanya, under a partnership with the private hotel developer, the Sanya Sunnybay Development Co., Ltd., the owner of the site's management rights. On-site evaluations identified high stress levels and recruitment failure, which confirmed the necessity for active interventions in order to increase reef resilience and to provide time to address the threats. TNC is closely engaged with the partner and planning to introduce coral gardening, algal and predator removal, marine education to the project site, and to explore fisheries interactions with local community. This project has generated a growing interest among local stakeholders that rely on reef-related tourism. TNC aims to demonstrate a model for partnership between the conservation community and the private sector, and to initiate a business alliance for conservation. This alliance is viewed as essential opportunities for engaging the local and provincial governments in long-term regional strategies to address fundamental issues such as water quality.

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DIGITIZING THE CORAL REEF: SURVEYING THE BIODIVERSITY OF CORAL REEF BENTHOS USING UNDERWATER HYPERSPECTRAL IMAGING (Abstract ID: 29178)

Coral reefs are characterized by a high degree of spatial complexity and biodiversity. Rapid large-scale surveys at a fine spatial resolution and automation of substrate recognition will help to quantify the spatial structure of the reef's biodiversity. This is a pre-requisite to assess changes, both natural and anthropogenic, in the ecological status of

coral reefs. We describe a novel method to survey and map the biodiversity of coral reef benthos using a diver-operable hyperspectral imager called hyperdiver. The hyperdiver survey technique captures spectral and visual images, topography, water chemistry and light field data from survey transects. The technique combines the information derived from high-resolution spectra and imagery to feed a machine learning analysis, which can be used to create classified reef maps down to the taxonomic level of genera. Comparison of machine classification against expert analysis of taxa shows very good congruence. Consequently, the hyperdiver technique allows us to rapidly visualize the biodiversity of the reef benthos from the centimeter scale upwards, along with profiling the bedform rugosity and light climate. We used hyperdiver to survey unique Pacific reefs near natural CO2 vents and reefs nearby unaffected by elevated CO2 levels. The survey covered several kilometers, and the data was used to create classified reef maps with 1-2 cm spatial resolution. We visualized and analyzed the strong effects of ocean acidification on the composition and rugosity of the benthic assemblage from the centimeter to reef scales.

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SIMULATING THE DYNAMIC TRANSITION FROM REGIONAL DESIGNS TO LOCAL ACTIONS (Abstract ID: 28670)

Regional-scale conservation planning is important to allow emergent system properties such as complementarity, connectivity of areas, and accounting for vital large-scale processes. Such scale of planning, however, results in a mismatch of scales between that of planning and implementing the plans, which occurs at local scales. Despite considerable acknowledgement of this issue in the literature, explicit strategies to facilitate this transition of scales are obscure and yet to be quantified. Using the computer language, 'R', we coded a framework to simulate dynamically transitioning from prioritised regional designs to implementing local actions, defined by management units, in the protracted application of conservation actions. We tested how the frequency of updating the regional design with local information on currently achieved objectives during the transition, influenced the extent of change in spatial configuration between the initial proposed design and the final implemented actions, measured with Cohen's Kappa statistic. Increased frequency of updating the regional design decreased the spatial similarity between the initial design and final actions. However, increasing the frequency of updates also increased the spatial and cost efficiency of implemented reserves compared to simulations with less frequent updates. Our findings refute current perceptions that the implemented network needs to be as spatially similar as possible to the best-proposed design, and that frequent revision of regional designs during the transition to implementation decreases efficiency.

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SHARKS AND RAYS OF THE SOLOMON ISLANDS: STATUS, THREATS AND A KNOWLEDGE REVIEW (Abstract ID: 27885)

The Solomon Islands lie within a global centre of coral reef biodiversity, and are a focal point for coral reef and fisheries research in Melanesia. However, little is known about the status and diversity of sharks and rays in the Solomon Islands. Nevertheless, sharks and rays are under increasing threat in the Indo-Pacific, and the limited data available suggests that they are taken in the Solomon Islands as target and bycatch in large scale commercial fisheries, artisanal and subsistence fisheries. Recognising these issues, in 2013 the Solomon Islands government stated its intent to develop a*National Plan of Action* for conserving shark resources. However, crucial baseline data about species status and biodiversity are needed to support these efforts. This project collated and analysed available information to assemble an account of the biodiversity, status, and current management of Solomon Islands' sharks and rays. Given the paucity of data available, a wide range of information sources were explored including published and grey literature, management documents, ethno-biological information and museum records, as well as opportunistic information from private individuals such as historical photographs. This information was compiled into an annotated species checklist, providing the first systematic review of Solomon Islands elasmobranchs, and includes global range extensions for species such as sawfish. This work also demonstrates the benefits of a broad scale, interdisciplinary approach when synthesising information about data poor regions and topics. https://research.jcu.edu.au/portfolio/andrew.chin

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A COMPUTATIONAL MODEL OF THE IMPACT OF UNI AND BI DIRECTIONAL FLOW ON COLONY SYMMETRY OF BRANCHING SCLERACTINIAN CORALS (Abstract ID: 30132)

Many branching scleractinian corals tend to develop symmetrical growth forms. A long-standing question is whether radial symmetrical colonies have emerged due to the environment condition such as water movement or genetic blueprint. To address this issue, we used a computational approach to study whether bi-directional current causing the radial symmetrical morphology of representative branching corals. Using advection-diffusion equations we linked an earlier developed coral growth model to simulated, but varying bi-directional flow environments. We investigated the relative importance of flow to the corresponding symmetry of the simulated morphologies by changing Peclet number. We compared the simulated results with in situ collected and CT-scanned colonies of the genus Madracis and the species Pocillopora verrucosa. The comparisons were based on 10 distinct morphometric traits comprising local morphometric traits, i.e. relevant to the local geometric property of the colony, and symmetry-oriented traits, that involve the measurement of how internal branches change relatively to the direction of the incoming flow. Our analysis shows a separation between symmetrical coral assemblies versus asymmetrical ones with some of the simulated corals under bi-directional flow environments overlapped with those of real colonies suggesting the symmetry of a branching colony can be explained by the influence of flow.

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EFFECTS OF TEMPERATURE AND SALINITY ON THE OXYGEN CONSUMPTION RATES AND BEHAVIORS OF THE NUDIBRANCH, JORUNNA FUNEBRIS (KELAART, 1858) (Abstract ID: 29634 | Poster ID: 43)

Temperature and salinity are primary environmental factors that influence metabolic rates of reef invertebrates. Changes of temperature and salinity can alter respiration rates and some behaviors of animals such as changes of movement and excretion. In this study, we investigated the effects of temperature and salinity levels on the oxygen consumption rates and behaviors of the nudibranch, Jorunna funebris (Kelaart, 1858). The results showed that the changes of both temperatures and salinity levels affected the oxygen consumption rates of the nudibranchs in all size classes. The results also showed that rates of oxygen consumptions of nudibranch increased with the increase or decrease of temperature and salinity levels. In addition, the temperature and salinity stresses caused nudibranchs inactive or more active than usual. More mucous secretion and increase of respiration rates were also observed.

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EFFECT OF MONSOON ON THE ASSOCIATION BETWEEN REEF FISH RECRUIT AND BENTHIC STRUCTURAL COMPONENTS (Abstract ID: 29043 | Poster ID: 243)

While it is recognized that reef fish recruitment is strongly influenced by benthic structural features, the strength of this relationship at different monsoonal periods have yet to be investigated. The study aims to fill this data gap and investigate if there is variation in the strength of pomacentrid recruit association with specific benthic structural characteristics across monsoon seasons in an established protected area in Mabini, Batangas, Philippines. In the study, we quantified the strength of association between pomacentrid recruit abundance with rugosity, vertical relief, loose abiotics and live coral cover. The surveys were conducted monthly during peak recruitment periods on four permanent 50m transects. Currently, data collection for inter-monsoonal (April to June) and southwest monsoonal seasons (July to October) has been completed. Survey for the northeast monsoonal period will be conducted from January to March 2016. Initial results showed that reef fish recruit and benthic structural characteristics association was strongest in the southwest monsoon. Significantly, during this period, more recruits were found associated with live coral cover and substrates with notable vertical relief. We hypothesize that recruits aggregate on these benthic features not only to minimize mortality due to predation but to also seek refuge against high energy waves brought about by strong winds during southwest monsoon. This study has important implications in management specifically in modeling the impacts of live coral and overall structural loss on reef fish recruitment.

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DRONES THAT SEE THROUGH WAVES - FLUID LENSING AS A NEW TECHNOLOGY IN OCEAN REMOTE SENSING (Abstract ID: 30146)

The use of small, unmanned aerial vehicles (UAVs, commonly known as drones) and experimental NASA-developed Fluid Lensing technology is presented as a novel means to image underwater marine ecosystems from above the ocean's surface, producing cm-scale imagery in three dimensions over tens of square kilometers. Fluid Lensing uses water-transmitting wavelengths to passively image underwater objects by exploiting time-varying optical lensing events caused by refractive distortions from traveling surface

waves. Preliminary high-resolution datasets present the first cm-scale image of a reef acquired from above the ocean surface without wave distortion and show clear distinction of coral, fish and invertebrate species at depths of up to 3 m. State-of-the-art machine learning algorithms were used to map coral morphologies and calculate percent cover with up to 5% accuracy vs. 25-50% error using current remote sensing technologies. Fluid Lensing thus improves upon existing state-of-the-art remote sensing technologies captured at meter-scale resolution by up to two orders of magnitude. These preliminary findings show Fluid Lensing and multirotor electric drones offer a unique and cost-effective solution for large-scale surveys of shallow marine biospheres.
http://www.nasa.gov/ames/fluidlensing/

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THE ROLE OF OPTICAL SPECTROSCOPY DATABASE SYSTEMS FOR MARINE CONSERVATION EFFORTS – WORKING TOWARDS INTERNATIONAL CAPACITY BUILDING (Abstract ID: 29943)

Optical spectroscopy data collected for marine system research can assist conservation efforts by offering valuable reference data crucial to sensor calibration, field validation campaigns, or as research data alone. While a wealth of spectroscopy data exists, often access is limited because data are stored locally and subject to the often disjointed lifecycle of research projects. Yet such data has the potential to benefit the wider marine system community as well as to contribute to international spectral libraries to fill existing gaps in collections. The crux of developing more holistic user-based data services is to meld efforts into sustainable research data capability. Capability building requires an evolution of the data services provided across the international sector which accommodates advancing practice. Distinct challenges are faced at this juncture, which ultimately depend on financial and user investment, but includes issues beyond user demands for system enhancements, including: community building, ethical clearance of data sharing, process development, project administration and liaison with the global community to promote international standards. Only if these elements are addressed, can infrastructure initiatives be embraced to build true international collaboration capability. This paper will present a brief summary of the Australian experience to serve as a catalyst of discussion regarding the sustainability of spectroscopy research data services and raise the challenges and issues that arise in the sustainable delivery of research infrastructure.

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OOCYTES EXPRESS AN ENDOGENOUS RED FLUORESCENT PROTEIN IN A STONY CORAL, *EUPHYLLIA ANCORA*: A POTENTIAL INVOLVEMENT IN CORAL OOGENESIS. (Abstract ID: 28041)

Sexual reproduction of corals is an important means of facilitating the generation of new coral reefs. To date, however, the molecular and cellular mechanisms underlying coral sexual reproduction remain largely unknown. We performed a differential screen to identify genes related to oogenesis in the stony coral *Euphyllia ancora*. We identified a clone encoding a novel *red fluorescent protein* cDNA of *E. ancora* (named *EaRFP*). Microscopic observation and quantitative RT-PCR revealed that EaRFP is almost exclusively expressed in the ovary of the adult coral. The combination of the ovarian-cell separation method and the RT-PCR analysis revealed that the oocytes, but not the ovarian somatic cells, are the cells expressing EaRFP. Immunohistochemical analysis revealed that the expression of EaRFP starts in the early stage of the oocyte and continues until the maturation period. Furthermore, recombinant EaRFP was shown to possess an $H_2O_2$degradation activity. These results raise the possibility that EaRFP plays a role in protecting the oocytes from oxidative stress from the early to late stages of oogenesis. The present study provides not only the first evidence for the potential involvement of FPs in coral oogenesis but also an insight into a cellular strategy underlying coral sexual reproduction.

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IMPACT OF EXOTIC SPECIES (BANTARIELLA BOCKI) ON GORGONIAN AND BLACK CORAL AT JEJU ISLAND IN KOREA (Abstract ID: 29148 | Poster ID: 219)

In 2015, bryozoan, Bantariella bocki was observed to be increasing rapidly on the Seogwipo coast of Jeju Island. It was observed that the colonies of coral (Gorgonian and Black Coral) were entirely covered with B. bocki. Attached B. bocki had a significant impact on the survival rate of coral. This invasion may be contributing to a decrease in black coral and endemic gorgonian coral at shallower depths. In particular, the same phenomenon of rampant B. bocki was observed in 2005. We conducted a study to find the cause of this sudden increase in B. bocki. We investigated the influence of the environment such as seawater temperature, turbidity, and changes in topography. Secondly, to investigate the quantitative change in invasion rates, 60 colonies grouped according to invasion rate ranges of 0~30%, 30~60, 60~100% were individually tagged at the beginning of this study. We also measured the mortality and recovery rate of coral. Increase in B. bocki showed a correlation with seawater temperatures. The invasion rate of corals showed a maximum effect at 20~30m, and small colonies showed higher rates of death.

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DOES NUTRITIONAL ECOLOGY DRIVE THE EVOLUTION OF LIFE HISTORIES IN HERBIVOROUS REEF FISHES? (Abstract ID: 27904)

Reef fish have distinct life history signatures with differences driven by variable longevities, sexual ontogeny and somatic growth. We commence analysis of the processes responsible for life history diversification by focussing on herbivorous reef fishes comprising 5 major clades (pomacentrids, scarine labrids, acanthurids, siganids and kyphosids). There is strong phylogenetic structure associated with herbivory. Reef herbivores access a range of autrotrophic resources with processes associated with digestion and assimilation being highly clade-specific. Those with short life spans, high growth and episodes of rapid somatic and reproductive outputs harvest autotrophic resources rich in protein. Conversely those species with extended life spans and low rates of somatic growth obtain energy and nutrients via carbohydrates through fermentative digestion. We evaluate how nutritional ecology influences life history signatures. Our hypothesis is that the dominant herbivores on coral reefs, parrotfishes, have food processing modes that allow harvesting of protein rich microbial biomass which underwrites their protogynous life history. Conversely acanthurids maintain a life history with modest annual somatic growth and reproductive outputs maintained by processing of carbohydrates. Temporal patterns of diversification in each clade are distinct; parrotfish diversified in the Pleistocene while surgeonfishes have an Eocene history. We identify the recent diversification of parrotfishes as a unique trophic event with profound consequences for reef ecosystems.
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RESERVE NETWORK DESIGN TO DELIVER REAL-WORLD CONSERVATION AND FISHERIES BENEFITS (Abstract ID: 28823)

Recognising the need to preserve nature for its sustainable use, the science of reserve design has become more pragmatic. An ideal network of marine reserves ought to promote the persistence of metapopulations while benefiting fisheries by replenishing nearby areas through adult and larval spillover. So far reserve network design has focused on optimising local persistence through the use of rules of thumb for the entire network (e.g. minimum reserve size based on average dispersal distances) or static measures that characterize each site (e.g. self-retention). Several studies have considered closed loops of replacement that could allow the persistence of the network as a whole, but these have focused on assessing the value of particular network configurations, not on choosing an optimal design overall. Here we design a network of reserves to accomplish conservation and fisheries objectives using a spatially realistic seascape, and the linkages among nearby populations in terms of adult and larval connectivity. Our reserve network design considers seascape management units and uses dynamic population models to identify optimal reserve network configurations that allow the persistence of the metapopulation while maximising fisheries yield. To our knowledge, the study represents the first example of a reserve network that has been designed for fisheries benefits while considering network persistence. The resulting network design will be implemented in Honduras.

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IUU FISHING HAMPERED NO-TAKE MARINE RESERVE PERFORMANCE: A CASE STUDY FROM SIMCA, SABAH, MALAYSIA. (Abstract ID: 29042 | Poster ID: 673)

The benefits of no-take marine reserves are related to the efficacy of protection, where good protection stems from the combination of compliance and effective enforcement. This paper reports the occurrence of illegal, unreported, and unregulated (IUU) fishing within Sugud Islands Marine Conservation Area from 2006 to 2014. The illegal fishing activities were highly organized, occurred during odd hours of the day, and conducted at boundary between Malaysia and Philippine water. Fishing methodology categorized into dynamite fishing, sodium cyanide, bottom gillnet, trawling and hook and line. The intensity of dynamite fishing reached average to 30 blasts detected a day from August 2014 to September 2015. Fishing with sodium cyanide and hook and line targeting on Leopard Coralgrouper (Plectropomus leopardus) and Humphead wrasses (Cheilinus undulates) for the live reef food fish trade (LRFFT). Two illegal fishing targeting on Leopard Coralgrouper confronted from August 2013 to September 2014. Fish census conducted on the density of Leopard Coralgrouper before and after two fishing incidents showed that the fish population abundance was reduced to 5.33 ± 2.39 (N =12) fish per census, from 29.42 ± 13.24 (N = 24) fish per census and after the two incidents. Fishing on spawning aggregation has reduced large reproductive Leopard Coralgroupers of up to 80%. This paper shows that illegal fishing continues posting threat to MPA in Malaysia. Illegal activity hampered the overall effectiveness of a no-take marine reserve for the recovery of fish biomass and density.

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PROTEOMICS OF SYMBIOTIC FUNCTION, DYSFUNCTION AND RECOVERY IN REEF-BUILDING CORALS (Abstract ID: 28065 | Poster ID: 16)

Because we are in the midst of alarming losses of coral reefs owing to mounting levels of environmental stress, a much fuller understanding is required of how coral symbiosis is regulated if we are to predict the impact of environmental change on the future resilience of tropical coral reef ecosystems. The photosynthetic bleaching response of Acropora formosa, Stylophora pistillata and Pocillopora damicornis collected from the Great Barrier Reef were previously compared under empirical conditions of environmental stress (Beltran et al., 2012). Briefly, after 48 h of stress (high light/low temperature, high light/high temperature, and low light/high temperature), A. formosa was found to be a thermally-sensitive species under both light conditions, S. pistillata was thermally-tolerant but light-sensitive, while P. damicornis was least sensitive to bleaching and showed attributes of light and thermal tolerance. Protein samples were collected at T=0, T=24h and T=48h during each treatment for quantitative high-throughput proteomic analyses of the intact coral holobiome. Such data provides a vital backdrop to examine the effects of heat and light on coral bleaching and the reacquisition of algal partners in post-stressed corals, which will be discussed in context with our experimental photophysical observations.
Beltran VH, Dunlap WC, Long PF. (2012) Comparison of the photosynthetic bleaching response of four coral species common to the central GBR. Proceedings of the 12th International Coral Reef Symposium, 9–13 July 2012, Cairns, QLD, Australia.
https://kclpure.kcl.ac.uk/portal/paul.long.html

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BRIGHT SPOTS AMONG THE WORLD'S CORAL REEFS (Abstract ID: 27887)

Ongoing declines among the world's coral reefs require novel approaches to sustain these ecosystems. A presently untapped approach is systematically identifying and learning from outliers- places where ecosystems are substantially better (bright spots) or worse (dark spots) than expected, given the environmental and socioeconomic conditions they are exposed to. We compile data from 2,500 reefs and develop a Bayesian model to generate expectations of how sreef fish biomass is related to 18 socioeconomic drivers and environmental conditions. We then identify 15 bright and 35 dark spots, defined as sites that had biomass levels two standard deviations from expectations. Bright spots were not simply comprised of remote areas with low fishing pressure- they include localities where human populations and use of ecosystems resources is high, potentially providing novel insights into how communities have successfully confronted strong drivers of change. We surveyed experts about conditions at these sites to reveal that bright spots were characterised by strong sociocultural institutions such as customary tenure, high levels of local engagement in management, high dependence on marine resources, and beneficial environmental conditions such as deep-water refuges. Alternatively, dark spots were characterised by intensive capture and storage technology and a recent history of environmental shocks. Our results suggest that investments in strengthening fisheries governance could facilitate innovative conservation actions that help communities defy expectations of global reef degradation

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CORAL-SYMBIODINIUM INTERACTIONS ACROSS A GRADIENT OF LOCAL STRESSORS ON KIRITIMATI ATOLL (Abstract ID: 29057)

The resilience of coral reef ecosystems is shaped by a variety of dynamic coral-symbiont interactions. Corals host a variety of single-celled algae (Symbiodinium) clades and types, some of which are better suited to sustained environmental stress than others. Some clades, such as clade D, provide increased thermal tolerance in stressed coral colonies, although not without certain functional drawbacks. Determining the mechanisms behind changes in coral-Symbiodinium interactions is essential to understanding the ability of the coral symbiome to adapt to climate change and other anthropogenic stressors. For this study, we evaluated the dynamics of Symbiodinium communities within coral colonies across a gradient of human disturbance (i.e. coastal nutrient input and fishing pressure) on Kiritimati atoll (Christmas Island). We collected coral tissue samples for three coral species (P. lobata, M. foliosa, and P. eydouxi) and analyzed them using MiSeq ITS2 amplicon sequencing with a clustering approach and Minimum Entropy Decomposition. We found coral species-specific patterns in symbiont genetic diversity that persisted across the human disturbance gradient, and site-specific distribution of "sub-optimal" symbiont types. By describing the relationship between local stressors and coral symbiont genetic diversity, these results assist in elucidating interactions between human disturbance, coral-symbiont interactions, and broad-scale reef ecosystem resilience.

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IMPROVING THERMAL STRESS REPRESENTATION ON OCEANOGRAPHICALLY DIVERSE PACIFIC REEFS USING A COMBINATION OF IN SITU AND SATELLITE DATA (Abstract ID: 28871)

Coral reef managers increasingly use satellite products to monitor thermal stress on reefs due to the ease of accessibility and near real-time updating of these data. Despite improvements in spatial resolution to satellite sea surface temperature (SST) data, there is still variation in how well these data correspond to temperatures on coral reefs. Here, we use a dataset of 62 temperature loggers deployed across the Pacific from 2005 to 2012 to investigate how SST data represent in situ temperatures (IST) at a range of depths and oceanographic regimes. At many sites, SST data agree well with IST, with low (≈ 0.3°C) mean differences that are consistent year-round. However, at some locations, particularly deeper reefs at higher latitudes or in upwelling regions, SST can over-estimate IST by, on average, 1°C or more and with substantial seasonal variability. We apply the Coral Reef Watch Degree Heating Week (DHW) metric to IST to quantify in situ accumulated thermal stress, comparing this with corresponding DHW values from SST data. We calculated the in situ version of DHW for each site after adjusting the SST-derived Maximum of the Monthly Means (MMM) climatology by the average difference between the SST and IST datasets. This improved the correlation between satellite and in situ DHW values on reefs where temperatures were much lower than their overlying SST. This highlights the potential for the development of new techniques using both satellite and in situ data to better estimate thermal stress across a broad range of reef environment characteristics, including depth.

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SUCCESSFUL CONTROL OF CROWN-OF-THORN STARFISH IN AMERICAN SAMOA (Abstract ID: 29088)

Population outbreaks of the coral-eating crown-of-thorn starfish (Acanthaster planci) are a significant threat to coral reefs. Control of large-scale outbreaks has had limited success despite over 100 attempts to control outbreaks populations (Rivera Posada et al., 2013). However, efforts continue to control outbreaks due to the importance of coral reefs to local communities and dive tourism. This study reports on successful efforts to control a small outbreak of A. planci in the National Park of American Samoa using methods refined over a 4 year period. Outbreaks of A. planci were detected using a simple but effective surface towboard technique, which allowed 50km of coastline to be surveyed in 3-4 days. Eradication efforts were targeted to areas with high A. planci densities. Subdermal injection of either sodium bisulfate or oxbile was used as a poison agent. Oxbile proved to be more efficient since only a single injection was needed to kill

the individual, while sodium bisulfate required the animal to be removed from the reef to administer 10-15 injections. These methods resulted in the elimination of over 25,000 individuals over a 34 month period, saving an estimated 285,000 m2 of coral reef from A. planci predation. Coral cover in park waters between 10 and 20m depth showed no significant change during this period, and densities of A. planci has been reduced to below outbreak levels. This study demonstrates a refinement of techniques that eventually proved to be very effective in controlling A. planci outbreaks in limited areas during small population outbreaks.

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A MULTI-DISCIPLINARY APPROACH TO UNDERSTANDING HISTORICAL CHANGES IN CORAL COMMUNITIES (Abstract ID: 28627)

Long-term data with high-precision chronology are essential to elucidate past ecological changes on coral reefs beyond the period of modern-day monitoring programs in order to appropriately assess the current status of reefs. In 2012 we revisited two inshore reefs within the central Great Barrier Reef, where a series of historical photographs document a loss of hard coral cover between c.1890-1994 AD. Here we use an integrated approach that includes anecdotal historical evidence (photographs), elevation and ecological surveys, as well as high-precision U-Th dating specifically tailored for determining the age of extremely young corals, to provide a robust, objective characterisation of ecological transition. The timing of mortality for most of the dead in situ corals sampled from the historical photograph locations was found to coincide with major flood events in 1990-1991 at Bramston Reef and 1970 and 2008 at Stone Island. Evidence of some recovery was found at Bramston Reef with living coral genera similar to what was described in c.1890 present in 2012. In contrast, very little sign of coral re-establishment was found at Stone Island suggesting delayed recovery. These results provide a valuable reference point for managers to continue monitoring the recovery (or lack thereof) of coral communities at these reefs. A similar approach can be applied to other reef locations where an accurate chronology for the timing of substantial declines in coral cover, shifts in species composition and associated drivers are required.

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SUB-REGIONAL VARIABILITY IN THE CORAL BLEACHING RESPONSE AT NINGALOO REEF DURING THE 2010/11 LA NIÑA: PERTURBATIONS IN THE CORAL SR/CA PALEOTHERMOMETER (Abstract ID: 29221)

During the summer of 2010/11 a regional warming event driven by strong La Niña conditions caused coral bleaching of historically unprecedented severity along the western coast of Australia including the 300-km Ningaloo Reef Tract. However, highly contrasting degrees of coral bleaching severity were observed from two nearshore reefs located just 20km apart (~20% at Tantabiddi and ~90% at Bundegi); thus, suggesting that thermal stresses imposed at these two reefs varied considerably during this regional warming event. We measured records of Sr/Ca at monthly resolution over a period spanning ~17 years (1996-2013) from cores collected from massive Porites sp. corals at Tantabiddi and Bundegi to assess the response of this normally reliable paleothermometer proxy to acute periods of thermal stress. We found that there was a strong (~65%) temporary decline (~6 months) in the slope of the Sr/Ca-temperature correlation in the Bundegi coral beginning in the summer of 2010-11. In contrast, changes in the slope of the Sr/Ca-temperature correlation from the Tantabiddi were more muted; ranging from -20% to +7% of the slope for the entire 17-year record) and were more likely the result of sampling inconsistencies related to coral growth effects. The strong reduction in slope observed in the Bundegi record was observed to be similar to that expected to occur between day versus night-time calcification. We thus hypothesise that during periods of elevated thermal stress, enhanced Sr/Ca ratios reflect both a decline in photosynthesis and reduced activity of the Ca2+ATPase enzyme.

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REEF FISHERIES MAY NOT ALWAYS BENEFIT FROM TRANSITION OF LOCAL FISHERS INTO TOURISM: A SIMULATION STUDY (Abstract ID: 30030)

Excessive fishing pressure has been identified as a key driver of degradation of coral reefs. As a logical response, tropical marine conservation initiatives often encourage the transition of fishers into (eco-)tourism. In addition to reducing fishing pressure, this strategy is also seen as a way to improve the social and financial situation of fishers, and creates local stewardship of natural resources. Using simulations of model systems with varying parameters, we demonstrate that while such initiatives may result in benefits to the fishers who made the transition to tourism, conservation gains depend heavily on the local context. Fishing pressure is unlikely to decline in systems where (1) catch per unit effort remains high, (2) tourist opportunities are limited or seasonal, (3) the fishing industry is shaped by external drivers, and/or (4) local fishers can be replaced by immigrant fishers. In addition, various realistic scenarios illustrate that conservation strategies based around developing alternative income opportunities for fishers can be counterproductive.

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SEA STAR PREDATION THREATENS CORAL PERSISTENCE IN SMALL RESERVES (Abstract ID: 27847)

Habitat fragmentation and trophic downgrading of ecosystems worldwide has led to numerous instances of mesoconsumer overabundance that dramatically alter ecological interactions and processes. On Indo-Pacific coral reefs, population outbreaks of the crown-of-thorns sea star*Acanthaster planci* (COTS) are a primary cause of coral decline, and determining the ecological contexts that promote or hinder outbreaks is crucial to successful coral reef management. We explored the population and behavioral dynamics of COTS within a network of small, no-take marine protected areas (MPAs) in Fiji. Using a combination of observational and manipulative experiments, we found that COTS densities were 2.1-3.4 times greater within MPAs than in adjacent fished areas and that sea stars accumulated in MPAs via selective movement from fished areas into coral-rich MPAs. These findings are contrary to previous studies that suggest reduced fishing pressure, such as via the establishment of MPAs, may help regulate COTS outbreaks by fostering more intact food-webs that can exert top-down control on COTS populations. We propose that key reserve features including small size and marked differences in habitat quality (coral abundance) between protected and fished areas may lead to concentrated COTS feeding within reserves. These findings highlight the context-dependent nature of corallivory, as well as its implications for the conservation and management of small, relatively intact MPAs embedded within a background of degraded, coral-impoverished reefs.

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ASSESSMENT OF THE FUNCTIONAL COMPLEMENTARITY AMONG GRAZING HAWAIIAN SURGEONFISH: A MULTI-PRONGED APPROACH (Abstract ID: 29862 | Poster ID: 584)

Herbivores on coral reefs are instrumental in mitigating the competitive interactions between reef-building corals and fleshy algae; however, not all herbivores provide the same ecological function. Grazers/ detritivores consume turf algae (and associated organic matter), which are the primary spatial competitors to corals in the Main Hawaiian Islands. This study highlights functional diversity among surgeonfishes through observations of foraging behavior, analysis of stomach contents, and analysis of stable isotopic signatures of muscle tissue (d13C and d15N) for three common species (*Acanthurus nigrofuscus*, *Acanthurus olivaceus*, and *Ctenochaetus strigosus*) on the leeward side of Maui. Similar foraging behavior was observed in *A. nigrofuscus* and *C. strigosus*, with both biting primarily on turf; *A. olivaceus* grazed primarily sand in addition to turf. Diet composition based on stomach contents was different among species, and variation in composition was influenced by site. Measured d15N values indicate similar trophic position in the three species; however, d13C values varied among species at different sites, indicating consumption of different algal resources. Collectively, these data suggest that surgeonfish grazers exhibit significant within-guild functional diversity with respect to impact on the turf community; however, the differences and degree of divergence revealed depend on the methods used.

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DEVELOPING TRANSGENIC TOOLS TO STUDY CNIDARIAN-SYMBIODINIUM SYMBIOSIS IN A SEA-ANEMONE MODEL SYSTEM (Abstract ID: 29156 | Poster ID: 24)

Transcriptomic studies in cnidarians have identified many intriguing gene-expression correlations with the establishment and breakdown of symbiosis. Nonetheless, the molecular bases of these processes remain poorly understood, in part because of the lack of a tractable genetic system to functionally test candidate genes and pathways. The small anemone Aiptasia is symbiotic with Symbiodinium and has many experimental advantages over corals, including a high – but as yet unrealized – potential for the needed genetic studies. As a first step in developing transgenic methodologies, we are attempting to express fluorescent proteins from both capped-mRNA and Aiptasia-promoter expression constructs. If successful, these technologies should allow both expression of tagged proteins for localization studies and the overexpression of candidate genes to analyze gain-of-function phenotypes. To introduce the constructs, we are using both various electroporation protocols with adults and larvae and microinjection of zygotes. In parallel, we are developing tools to knock down and knock out genes using morpholinos and CRISPR-Cas9 for analysis of loss-of-function phenotypes. If both gain-of-function and loss-of-function methods can be established, Aiptasia should become a uniquely powerful genetic model system for the study of cnidarian-Symbiodinium symbiosis.

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COMPARISONS OF PHOTOSYNTHETIC FUNCTION OF SYMBIODINIUM GROWN IN CULTURE AND IN HOSPITE (Abstract ID: 29622 | Poster ID: 129)

Symbiodinium provides the cnidarians with the great majority of its fixed carbon, while the animal may allocate nutrients to the alga and offer the alga a safe haven. We are examining the photosynthetic activities of various Symbiodinium isolates, specifically probing differences in the ways in which these algae perform photosynthesis in the free-living relative to the endosymbiotic lifestyle? Photosynthetic electron transport is composed of linear and cyclic electron flow. In linear electron flow, electrons are extracted from water by the oxygen evolving complex of photosystem II (PSII) and then are transferred sequentially to the plastoquinone pool, the cytochrome b6f complex, plastocyanine, photosystem I (PSI) ferredoxin and ultimately to NADP+ to yield reducing equivalents. In cyclic electron flow, electrons are cycled around PSI to establish a proton gradient that can be used for the generation of ATP. Using both fluorescence and spectroscopic assays, we have measured the extent of both electron flows in Symbiodinium both in culture and in hospite. In our initial studies we have observed that PSI is more oxidized when the alga is associated with its animal host than when grown in culture under the same light conditions. These results suggest that the animal represents a strong sink for the reductant (fixed carbon) generated by the alga, as expected. The link between this damage under stress conditions, overall photosynthetic activity and the loss of the alga from the animal host, is being explored in detail in a collaboration of the Pringle-Grossman laboratories.

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IMPACT OF THE LIONFISH (PTEROIS VOLITANS) IN THE REEF FISHES ASSOCIATIONS IN TWO CARIBBEAN MARINE PROTECTED AREAS (CUBA AND MEXICO). (Abstract ID: 28409 | Poster ID: 633)

The effectives MPAs are an essential tool for the management and conservation of fishes communities. However, these MPAs may be exposed to the invasion of alien species as Pterois volitans. Such is the case of the Guanahacabibes National Park, Cuba and Reefs of Xcalak National Park, Mexico. In both areas visual census (line transect censuses and stationary) were performed to assess the structure and composition of fish assemblages and their conservation status, and its relation with the distribution and abundance of lionfish. The number of individuals of all species observed and the size were estimated from 2010 to 2015.In Guanahacabibes the values of density, height and biomass increased significantly from 2010 to 2013, probably due to the lack of management actions with the lionfish and the favorable conditions in the area (food and shelter). Xcalak values of density, biomass and size were very low, due to the protected area management with the species. The MPA authority perform catches of this species all year through temporary employment programs. In Guanahacabibes 411 individuals of lionfish were captured for the analysis of stomach content. We identified in the diet of lionfish, 10 orders, 19 families and 35 species. Fishes was the best represented group and the families with the highest incidence were Gobiidae, Pomacentridae, Mullidae, Labridae and Scaridae. In Xcalak 128 stomachs were analyzed, reporting 3 orders, 7 families and 10 species. The families with the highest incidence in the diet were Gobiidae, Labridae, Pomacanthidae, Balistidae and Monacanthidae.

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WARMING AND ACDIFICATIONALTER SKELETAL MORPHOLOGY OF THE REEF-BUILDING CORAL *SIDERASTREA SIDEREA* (Abstract ID: 28336)

Increasing ocean temperatures and decreasing seawater pH threaten coral reefs worldwide. Controlled laboratory experiments were conducted to investigate and quantify the effects of temperature (25, 28, 32°C) and CO2-induced ocean acidification (PCO2 = 324, 477, 604, 2553 µatm) on the skeletal morphology of the resilient Caribbean reef-building coral *Siderastrea siderea*over a 95-day interval. Post-treatment *S. siderea* corallites were imaged via stereomicroscopy to evaluate effects of warming and acidification on corallite height and infilling. Reduced (25°C) and elevated (32°C) temperatures both resulted in increased corallite height but decreased corallite infilling relative to the control. In contrast, corals reared under the lowest (324 µatm) and highest PCO2 treatments (2553 µatm) exhibited both decreased corallite height and decreased corallite infilling relative to the control. Interestingly, warming (32°C) and acidification (604 µatm PCO2) projected for the end of the century both resulted in increased corallite height and reduced corallite infilling relative to the control. Our results suggest that corals exposed to increased warming or acidification will modify the skeletal morphology of *S. siderea* by the end of the 21st century, which may exacerbate observed declines in coral health across Caribbean reef systems.

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MULTI-METHOD APPROACH TO MONITORING A REEF-ASSOCIATED WHALE SHARK AGGREGATION IN THE RED SEA (Abstract ID: 29267)

The whale shark (*Rhincodon typus*) is known to aggregate seasonally in specific sites within its circumglobal range. Among these is Shib Habil, an inshore reef off the western coast of Saudi Arabia where whale sharks are known to gather each spring. In 2010 an array of 32 acoustic receivers was installed on and around Shib Habil. From 2009-2015, 59 satellite and 91 acoustic tags were deployed on sharks in the Red Sea, including 33 animals that were fitted with both. Satellite telemetry demonstrated strong population-scale site fidelity to the southern Red Sea. Based on the acoustics, the aggregation season was defined as February through May; these months account for over 90% of whale shark detections in the area. Levels of activity were compared between receiver stations and the most active receivers also account for over 90% of whale shark detections. Approximately 40% of acoustically tagged sharks were detected again the following year. Satellite data shows that 12 of these phylopatric sharks migrated hundreds of kilometers away from Shib Habil between aggregation seasons. Establishing this baseline serves as a point of comparison as conditions change through time. For instance, we anticipate being able to show whether a recent bleaching event at Shib Habil correlates to a change in the aggregation during the coming season.

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A MULTI-PLATFORM APPROACH TO MAP THE U.S. CORAL REEF TASK FORCE FAGA'ALU BAY WATERSHED PARTNERSHIP INITIATIVE PRIORITY STUDY AREA, TUTUILA, AMERICAN SAMOA (Abstract ID: 28256 | Poster ID: 445)

The coral reef in Faga'alu Bay, Tutuila, American Samoa, has suffered numerous natural and anthropogenic stresses. Areas once dominated by live coral are now mostly a rubble surface covered with turf or macroalgae. In 2012, as part of the U.S. Coral Reef Task Force Watershed Partnership Initiative, Faga'alu Bay was designated as a priority area on which to focus research and restoration to help improve the health and viability of the coral reef ecosystem. To support these ridge-to-reef efforts, the U.S. Geological Survey mapped nearly 1 $km^2$ of seafloor to depths of about 60 m using a combination of WorldView-2 satellite imagery, IKONOS satellite-derived pseudobathymetry, and

underwater video and photographs. The resulting benthic habitat map uses a 100 $m^2$ minimum mapping unit (MMU), which is more applicable to ecological studies and management than previous maps of the area. Unconsolidated sediment (predominantly sand) constitutes slightly greater than 50% of the seafloor in the mapped area; reef and other hardbottom potentially available for coral recruitment constitute nearly 50% of the mapped area. Of this potentially available hardbottom, only slightly greater than 37% is colonized with at least 10% live coral, which is fairly evenly distributed between the reef flat, fore reef, and offshore bank/shelf. This benthic habitat map documents current baseline conditions and will assist with future monitoring and management.

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EVERY POPULATION MATTERS: HOTSPOTS OF GENOME-WIDE GENETIC DIVERSITY IN HAWAIIAN 'OPIHI (*CELLANA EXARATA*) (Abstract ID: 29760)

Populations with low genetic diversity can be particularly vulnerable to environmental and anthropogenic stressors due to the loss of advantageous mutations. Population genetic theory predicts that genetic diversity will scale with population size. In this study, we use genome-wide surveys of genetic variation in 'opihi (*Cellana exarata*) from the Hawaiian islands (HI) to test for a relationship between genetic diversity and population size. Historical 'opihi population sizes (pre-human colonization) are predicted to have ranged from ~1E6 to 1E8 and have been reduced by up to four orders of magnitude by harvesting. Contrary to expectations, nucleotide diversity exhibited a strong negative relationship with historical census population size but was unaffected by harvesting. These results indicate that 'opihi populations within the main HI are not in equilibrium and have experienced a major bottleneck in pre-human times, followed by a net population expansion. Two alternative explanations are (1) either 'opihi was extirpated from the main HI and they were recolonized from populations in the Northwestern HI or (2) demographic history, migration and mutation rates have led to a predictable non-equilibrium relationship between diversity and population size. Overall, these results suggest that the 'opihi in the Northwestern HI harbor a stockpile of genomic diversity, despite relatively small population sizes. Depending on the locus, however, every island harbors a genetic diversity hotspot, and management plans should focus on maintaining genetic diversity range-wide.

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LARVAL BIOLOGY OF THE CARIBBEAN OCTOCORAL ANTILLOGORGIA AMERICANA AND ITS IMPLICATIONS FOR DISPERSAL (Abstract ID: 30018)

Interest in the extent of larval dispersal and population connectivity of coral reef taxa has increased exponentially. While new methodological approaches have greatly improved our understanding of larval dispersal, the role of larval biology in controlling dispersal remains largely unknown. We characterized spawning, larval development, swimming behavior, longevity, survivorship and settlement of the Caribbean octocoral Antillogorgia americana in the Florida Keys. Colonies of A. americana split-spawned over two major events two weeks apart, 5 and 20 d after the full moon of November 2014. Fertilized eggs developed into motile planulae over 2-3 days. Despite the fairly rapid onset of competency to settle (4 d), the great majority of larvae delayed settlement for an extended period of time, with 50 and 95% of the original cohort settling/dropping onto the substrate by 36 and 58 d, respectively. Egg buoyancy and larval swimming behavior changed with age. Eggs were positively buoyant with a mean rising velocity of 0.17 cm/s. There was a significant decrease in vertical velocities during embryogenesis, but following the onset of larval swimming behavior velocities gradually increased. Larval mortality in the laboratory was extremely low (10% over 58 d). Behavioral data such as these are critical to modeling larval dispersal, and these efforts are currently underway. The pattern of a long delay in settlement, allied with negative geotactic swimming behavior should lead to a high dispersal potential, which may explain the broad distribution of A. americana in the Caribbean.

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EARLY SYMBIONT ACQUISITION WITHIN ACROPORA PALMATA AND ORBICELLA FAVEOLATA RECRUITS (Abstract ID: 29009)

The symbiotic relationship between dinoflagellate algae of the genus Symbiodinium and corals forms the base of the tropical reef ecosystem. Yet, despite their importance to the host, the majority of these symbionts are horizontally transmitted. We followed symbiont uptake in Orbicella faveolata and Acropora palmata recruits in the lab and field in the Florida Keys. Lab assays demonstrated that prior infection does not limit the ability of the O. faveolata recruits to acquire additional symbionts; however, the ability of asymbiotic O. faveolata recruits to acquire symbionts decreased after 4 months. Thus early exposure to Symbiodinium may benefit lab reared recruits (e.g., enhance growth) without limiting their ability to transition to natural Symbiodinium associations upon outplant. O. faveolata and A. palmata recruits, exposed to environmental symbionts in the lab and field, acquired a range of symbiont types, with those within Clade D dominating in samples collected over the course of 16 months. Interestingly, during a recent bleaching event, A. palmata yearlings did not visibly bleach. As with other coral species that initially acquire a range of symbiont types, these species may transition to the dominant symbionts found within these hosts in the Florida Keys (S. fitti and Symbiodinium within the B1 lineage for A. palmata and O. faveolata, respectively), but the presence of Symbiodinium within Clade D may provide resilience to recruits and its continual dominance would represent a potential mechanism to improve survival in response to local thermal warming events.

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THE ROLE OF BASIN-SCALE CLIMATE VARIABILITY IN THE DECLINE OF CARIBBEAN CORALS (Abstract ID: 29874)

Anthropogenic climate change is principle threat to coral reef survival. However, the effects of the projected decrease in nutrient export and net primary production (PP) resulting from enhanced stratification of the upper oceans, has received little attention. We generated century long growth histories from three dominant Atlantic coral genera using skeletal cores collected from live colonies across the Caribbean and Bermuda, and from fossils preserved in Last Interglacial reefs. We find that growth of modern corals has been in steep decline since the mid-70's. However these changes are cyclical rather than secular as coral growth exhibits coherent, large-amplitude decadal-scale changes through the 20th century. Similar patterns are evident during the Last Interglacial, suggesting that Atlantic corals respond strongly to basin-scale changes internal to the climate system. A comparison of our records with output from the MOM4 physical model shows that coral growth tracks changes in mixed layer depth (MLD). We further investigated the link to MLD using the nitrogen isotope ratio ($\mathbf{d}15N$) of skeletal bound organic (SBO) material. Interpreting our results within the framework of a coral-symbiont N recycling model suggests that coral heterotrophic feeding increases under MLD-fueled productivity, enhancing skeletal growth. The strong sensitivity of coral growth to past changes in productivity implies that the projected 21st century decline in net PP could potentially rival and will certainly exacerbate the effects of warming and OA on coral reef ecosystems.
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HATCHERY PRODUCTION OF TRIPNEUSTES GRATILLA FOR BIOCONTROL OF INVASIVE SEAWEEDS IN CORAL REEF RESTORATION (Abstract ID: 29722 | Poster ID: 476)

The native collector sea urchin Tripneustes gratilla is raised as a biocontrol to mitigate the effects of invasive seaweeds on indigenous corals in Kaneohe Bay, Hawaii. Animals are hatchery reared rather than transplanted from wild stocks so as not to cause an imbalance in other parts of the Island of Oahu. Tripneustes gratilla is being successfully raised in the hatchery at the Anuenue Fisheries Research Center in Honolulu. Wild broodstock are collected and spawned on a monthly basis. First feed is administered three days after fertilization. Larvae are grown in round tanks with mild aeration. They are fed a microalgae diet at an initial density of 30,000 cells per milliliter. Feeding density is adjusted as needed. Larvae are maintained in UV treated seawater, pre-filtered to one micron at a temperature range of 25C to 26C. Water is changed daily and tank changes are performed as needed to maintain hygiene. Competency in a majority of larvae is usually observed at 23 days post-fertilization. Competent larvae are moved to settlement tanks for metamorphosis. Settlement tanks are prepared with natural biofilms. Post-larval urchins are allowed to remain in settlement tanks and graze on biofilms for eight to twelve weeks. At 5mm to 7mm juvenile urchins are switched to a diet of cultured macroalgae. Within three to five weeks of feeding on macroalgae, urchins more than double in size and are ready for outplanting in Kaneohe Bay.

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TRACKING THE SIGNALING CARGO OF EXTRACELLULAR SYMBIONTS INTO HOST TISSUES (Abstract ID: 28617)

Animal-microbe symbioses are fundamental to animal physiology but how and where bacteria interact with their host, remain largely elusive. The mutualistic association between the Hawaiian bobtail squid, *Euprymna scolopes* and its luminous bacterium *Vibrio fischeri* is a powerful model to investigate signaling between the host and its microbial symbiont. In this system, bacteria are acquired *via* horizontal transmission within hours of hatching and colonize the light organ as an extracellular partnership. Here, we combined TEM and NanoSIMS imaging to visualize $^{15}$N-labeled bacterial products within the tissue of newly-hatched squids. The nuclei of epithelial cells in the light organ were highly enriched in 15N with hotspots localized in the nucleolus as early as 2 h following inoculation. Closer examination revealed labeling was concentrated in the euchromatin regions of the nucleus, where DNA is often under active transcription. Taken together, our results show that *V. fischeri*-derived molecules target the host nucleus. We also exposed squid to $^{15}$N-labeled outer membrane vesicles (OMVs) extracted from *V. fisheri* as they are known to play a key role in signaling between symbiotic partners. Interestingly, $^{15}$N-enrichment patterns were similar to squid inoculated with intact bacteria. We are now exploring the species-specificity of these labeling patterns using other bacterial species. The unique link between spatial and functional information provided by the NanoSIMS technology has the potential to open a new frontier for the study of communication between host and symbiont.

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VARIATION IN BIODIVERSITY OF CRYPTIC REEF FISHES ALONG A RED SEA ENVIRONMENTAL GRADIENT (Abstract ID: 28628)

Small cryptic reef fishes are one of the most underestimated communities in coral reef studies due to their small size, biases in sampling, and cryptic nature. This is particularly true in the Red Sea, where previous surveys to comprehensibly document fish assemblages have been limited to visually conspicuous species. We conducted standardized collections of small and cryptic fishes to formally identify fish communities and compared results along a gradient of oceanographic and ecological environments. To help resolve taxonomic difficulties, genetic techniques were used in addition to morphological characteristics to identify and catalog individuals. Approximately 200 OTUs (operational taxonomic unit) from 35 families were collected, identified, and vouchered. Abundance and diversity increased from the clear oligotrophic reefs in the north to the shallow turbid reefs in the south. Community composition differed among regions, largely driven by relative abundances damselfish and gobies. Only 40% of the OTUs could be confidently assigned to species. The diversity of this understudied group plays a potentially important role in the ecology of reef fish assemblages, particular in the transfer of energy between trophic groups, but our current understanding of this role is limited by the lack of taxonomic clarity. This study has established a valuable collection of vouchered specimens with the potential to uncover new species and confirm new records in the Red Sea. Overall, further work in this area will help to place the Red Sea in a wider biogeographic context.

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FRESH GROUNDWATER IMPACTS ON INORGANIC CARBON DYNAMICS IN COASTAL HAWAI'I (Abstract ID: 29995 | Poster ID: 380)

The shoreward margin of coral reefs contain many habitat types within a short distance, are affected by freshwater inputs, and can be heavily impacted by humans interactions. The aragonite saturation, a factor influencing how easily organisms can produce calcium carbonate, in this region depend on the salinity and the concentration of total inorganic carbon (TCO2) in groundwater. To determine the impact of freshwater on TCO2 dynamics between the shore and reef, total alkalinity and pH were measured in the morning along transects at six sites around Hawai'i Island. The pH of fresh groundwater differed among the sites, between 6.8-8.2 at the shoreline and increasing to 8.2 at the reef. At all sites, aragonite saturation was lower than open ocean conditions, and on average lower than most coral reefs worldwide. The magnitude of aragonite saturation decrease depended on watershed characteristics (geology, land use, precipitation) that controlled the groundwater pH and TCO2. To determine how TCO2 in fresh groundwater discharge varies across Hawai'i, USGS measurements of pH and alkalinity from coastal wells were used to calculate TCO2 of each aquifer unit. The well data and estimates from the nearshore data were significantly correlated. Statewide, only a few locations, including the Waianae coast of Oahu, have higher TCO2 than seawater, potentially buffering the impact of ocean acidification. Concerted effort to collect samples statewide and analyzed with a consistent method is needed to identify priority sites for monitoring the effects of ocean acidification.

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REGAL PHYLOGEOGRAPHY: RANGE-WIDE SURVEY OF THE MARINE ANGELFISH PYGOPLITES DIACANTHUS REVEALS EVOLUTIONARY PARTITIONS (Abstract ID: 29229)

The Regal Angelfish (Pygoplites diacanthus; family Pomacanthidae) occupies reefs from the Red Sea to the central Pacific, with distinct color morphs in the Indian Ocean to Red Sea and Pacific Ocean. To assess population differentiation and evaluate the possibility of cryptic evolutionary partitions in this monotypic genus, we surveyed mtDNA cytochrome b and two nuclear introns (S7 and RAG2) in 547 individuals from 15 locations. Phylogeographic analyses revealed four mtDNA lineages (d = 0.006 – 0.015) corresponding to the Pacific Ocean, the Red Sea, and two admixed lineages in the Indian Ocean, consistent with known biogeographical barriers. Both S7 and RAG2 showed strong population-level differentiation between the Red Sea, Indian Ocean, and Pacific Ocean. The only consistent population structure within these three regions was at the Society Islands, where surrounding oceanographic conditions may reinforce isolation. Coalescence analyses indicate a Pacific expansion (1.71 Ma) that gave rise to a Red Sea lineage (1.44 Ma) followed by a radiation of two lineages that currently occupy the Indian Ocean (0.93 – 0.72 Ma). Persistence of a Red Sea lineage through Pleistocene glacial cycles indicates a long-term refuge in this region. The affiliation of Pacific and Red Sea populations, apparent in cytochrome b and S7 invokes the possibility that the Indian Ocean was recolonized from the Red Sea, possibly more than once. Assessing genetic architecture in this widespread monotypic genus reveals cryptic evolutionary diversity that merits subspecific recognition.

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DISPERSION OF SEAGRASS PROPAGULES AND CONNECTIVITY AMONG MEADOWS IN THE GREAT BARRIER REEF WORLD HERITAGE AREA, QUEENSLAND, AUSTRALIA. (Abstract ID: 27828)

Severe tropical storms and floods in north- eastern Australia between 2007 and 2012 damaged or destroyed seagrass meadows along hundreds of kilometres of coastline. The subsequent deaths of turtles and dugong have led to the very status of our iconic Great Barrier Reef World Heritage Area being questioned. We examined how meadow loss at this scale may re-establish from the dispersion of propagules floating in the water. We conducted a study based around Townsville and Abbot Point in North Queensland using a 2 dimensional numeric model developed for studying water movement. We released virtual propagules in the model between August and November 2011 with actual wind and current data. Model results suggest connectivity between offshore meadows and inshore meadows is likely to be low, limiting their ability to provide a reservoir of propagules. Time of year, location of release and the location of the propagule (surface or sub-surface) influenced movement. Over an 8 week model duration most propagules remained between 30 and 60 kilometres of their release point but distances up to 950 kilometres were possible. Most movement was to the north –west. An initial analysis identified where propagules from many source meadows accumulate and re-establishment would be more likely and where meadows were not well connected to other meadows. We report on the value of this exercise and management implications.
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EL NINO IMPACT ON CORAL REEFS OF THE CENTRAL PACIFIC –USE OF SENTINEL 2, A TEST IN THE MARQUESAS (Abstract ID: 30162 | Poster ID: 344)

Last December, a powerful El Niño Southern Oscillation combined with waxed ambient sea surface temperatures entailed significant anomalies across the equatorial Pacific Ocean which are likely to stress hard coral reefs, cascading in the symbiotic algae expulsion

(bleaching). Given the remoteness and spread of coral reefs, remote sensing has increasingly been advocated for monitoring the dynamics of these ecosystems. A decade ago, the Landsat-7 satellite allowed the typology and bathymetry to be rendered as a world atlas by leveraging a 30-m spatial resolution. However, both this spatial resolution and the spectral dimensions remain too coarse to understand the benthic heterogeneity process occurring at the coral colonies scale and time series analysis was not conducted. The Sentinel-2 sensor has the potential to improve monitoring of the coral reefs ecology thanks to the increased spatial resolution and number of wavebands, and the European Space Agency has tasked ARGANS Ltd with support of the Italian CNR and un. of Tartu to develop the EO data processors, un. of Queensland being involved in their validation. Meanwhile, given the very likely thermal stress event, monitoring of the 2015-2016 coral bleaching in the central equatorial Pacific has started, i.e. surveys of the Northern Marquesas Archipelago (French Polynesia), South Kiribati and Norther Cook Islands. Field spectra and photoquadrats of shallow coral reef habitats in the Marquise isles enabled to "calibrate" the Sentinel-2 data alongside Landsat, as well as the very high spatial resolution Pléiades1.
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EVOLUTIONARY ADAPTATION POTENTIAL: FROM NOVEL SCIENCE TO PRACTICAL APPLICATION (Abstract ID: 29799)

Earth's ecosystems—and their ability to provide services and benefits—are changing at an alarming rate due to a combination of local stressors and global climate change. Perhaps the most pressing question in conservation and management is: how can we design our actions to help species survive and continue to provide the services upon which humans rely? We believe that the answer lies in designing management actions to encourage billions of evolutionary match/mismatch tests, allowing nature to draw from diverse portfolios to pick winning combinations of genes and species that will persist into the future. However, there is little in the way of a comprehensive scientific theory that describes how population size, demographic connectivity, and diversity (e.g., genomic, phenotypic, species) affect evolutionary adaptation potential, defined as the probability of finding successful evolutionary combinations and propagating those across environmental mosaics. Similarly, there is limited guidance available for managers and conservation professionals about actions they could take to promote adaptation via natural selection. In this talk, we will synthesize ideas presented in this session and discuss how this information can help to design conservation and management actions that will promote coral adaptation via natural selection.

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A PHYLOGENOMIC BACKBONE FOR SCLERACTINIA BASED GENOME AND TRANSCRIPTOME DATA. (Abstract ID: 29590)

Stony corals (Order Scleractinia) have been studied for decades because of their fundamental role in reef building and their excellent fossil record extending back to the Triassic. Nevertheless, our understanding of scleractinian evolution and taxonomy has changed profoundly with the recent advent of molecular phylogenetics. However, most phylogenetic studies to date are still based on only a handful of mostly mitochondrial loci and tend to focus on individual coral genera and families with very few studies addressing deeper nodes. A robustly supported phylogeny of the deepest nodes is therefore still missing. Here, we present the first Scleractinia phylogeny based on genomic data. Our dataset is comprised of newly sequenced RNA-Seq data for deep and shallow water Scleractinia and published genome and RNA-Seq data from other stony-coral and outgroup lineages. At present, our phylogenetic analyses include 27 samples that span 10 scleractinian families and additional sequencing is currently underway to further extend our taxonomic range. Phylogenomic matrices so far contain between 73 and more than 2500 exclusively Metazoan orthogroups that are shared by 50-90% of all samples. Our results provide a well-resolved, robust, phylogenomic backbone for Scleractinia, addressing long-standing questions about the monophyly of the so-called complex and robust clades as well as resolving the position of particular groups such as the family Pocilloporidae.

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CORAL REGULATION OF THE CALCIFYING FLUID IS AFFECTED BY SEAWATER DISSOLVED INORGANIC CARBON CONCENTRATION (Abstract ID: 28014)

In the context of ocean acidification, it is important to understand how modifications of the carbonate chemistry affect the mechanisms of calcification in corals, and how such effects at the cellular level are translated to the organismal level. To better understand the calcification mechanism of corals it is critical to determine the extent to which both biological and environmental factors influence the chemistry of the calcifying fluid (CF), where the skeleton forms. To distinguish the effects of varying seawater dissolved inorganic carbon concentration [DIC] from varying seawater pH, we manipulated seawater [DIC] while maintaining seawater pH constant and measured the responses of photosynthesis, calcification, and pH in the CF ($pH_{CF}$). Photosynthesis and calcification in the light and dark increased as a function of [DIC]. $pH_{CF}$ measured by confocal microscopy also increased with [DIC]. A second phase of experiments will be run to determine the effects of seawater [DIC] manipulations on the [DIC] in the CF using geochemical tools; the preliminary results will be reported during this presentation. This study shows that in addition to seawater pH, [DIC] can also modify chemical conditions in the CF, which in turn modulate the calcification rate of organisms. Understanding the key mechanisms controlling coral calcification is critical to making further progress in determining the response of coral reefs to OA.

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A FRAMEWORK TO ASSESS RIDGE TO REEF ECOSYSTEM HEALTH IN AMERICAN SAMOA (Abstract ID: 29509)

A coupled approach to assessing ecosystem health and functioning of coral reefs is important in prioritizing and protecting resources that millions of people are dependent upon for livelihood, cultural, and aesthetic uses. In American Samoa, the proximity of development and growing human population to watershed stream discharge areas predisposes reef communities to be adversely affected by non-point sources of pollution. This project aims to develop an ecosystem health index using water quality and coral reef monitoring protocols that can be used to assess the current status of streams and coral reefs, pinpoint specific sources of degradation, and provide spatially-explicit threat models highlighting areas where these stressors occur. Main tasks to be accomplished under this grant include: development of a framework to assess ecosystem health, training workshops on field monitoring and analyses methods, field surveys of coral reef and watershed sites in Tutuila, compilation and analyses of survey results for assessment of ecosystem health at the watershed level, and building local capacity in monitoring, analyzing, and disseminating results. The final products of this project will include: a comprehensive ridge to reef framework and baseline data that can be used to predict significant drivers of threat to ecosystem health at the watershed scale and a training toolkit using the ecosystem health monitoring criteria. The identification of the most important causes of reef impairment can help make informed decisions using innovative tools and comprehensive datasets that can enable systematic prioritization for protection of valuable coral reef resources in American Samoa.

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KEY PREDICTORS OF EXTINCTION RISK IN SEA BREAMS AND PORGIES (FAMILY: SPARIDAE) (Abstract ID: 27787)

Identification, understanding and prediction of the factors that drive species to heightened risk of extinction are important goals for conservation, especially since few areas on the planet remain unaffected by human activities. Global extinction risk assessments of an entire family of marine fishes (Family: Sparidae), using the International Union for Conservation of Nature Red List process, showed that 8.6% (13 species) of sparids were threatened. All have increased vulnerability to population declines from intense fishing pressure and habitat destruction. A further 7.9% were classified as Near Threatened. The majority of the sparids (69.5%) were assessed as Least Concern, while the remaining 21 species (13.9%) were listed as Data Deficient. In addition to presenting the first global assessment of sparid extinction risk, a Random Forest model was used to identify correlates of extinction risk in the Sparidae using 33 biological and threat variables. The model correctly classified up to 90% of Red List category placements and showed complex interactions between intrinsic and extrinsic predictors. Larger body size was the most important predictor of risk. Additional predictors included generation length, longevity, rocky reef habitat, recreational fishing, climate change, harvesting, area of occupancy, and lower depth limit. This analysis is the first time a predictive model of extinction risk has been applied to marine fishes and presents an opportunity to identify and mitigate threats affecting similar groups of highly valued and ecologically important marine fishes.

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RELATIVE RESILIENCE POTENTIAL AND CLIMATE VULNERABILITY OF CORAL REEFS ALONG THE WEST COAST OF HAWAI'I ISLAND (Abstract ID: 28558)

NOAA coordinates activities and expertise in the West Hawai'i Focus Area on the NW side of Hawai'i Island to address objectives on coral health, climate change and community capacity. To support and help guide these efforts, we have assessed the ecological resilience potential of 40 sites in this area by examining indicators of resilience processes (e.g. herbivore biomass and coral recruitment), and how spatial variation in anthropogenic stress and projected future climate stress influences exposure and resilience. We found: 1) exposure to anthropogenic and projected climate stress is higher in the northern part of the survey area than in the south, and 2) resilience potential varies greatly across the survey area. The assessment results are used to identify and tailor management strategies to improve resilience at low resilience sites and maintain resilience at high resilience sites. We have an expansive engagement plan to socialize and disseminate the project results in a strategic way to key stakeholders, including local community members. These communication and capacity building efforts are critical to increase support for and compliance with any management strategies implemented in the near future. This multi-disciplinary project uniquely combines recent advances in resilience science and application with climate modeling and social science. This powerful case study describes how scientists, managers and local community members can work together to examine and then reduce the climate vulnerability of coral reefs in Hawai'i.

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THE EFFECTS OF JAPANESE STYLE MPAS AND ACANTHASTER PLANCI ON CORAL COVER IN ISHIGAKI JAPAN (Abstract ID: 30081 | Poster ID: 451)

Marine Park Zones (MPZs) have been set up by the Japanese Ministry of Environment around the small island of Ishigaki in the Ryukyu archipelago in the attempt to protect dwindling populations of coral in the area. This study attempts to determine whether or not the management scheme has been successful. A combination of field surveys and existing time series data analysis has shown that the coral reef community appears to grow and decline independently of the MPZ system. An outbreak of Acanthaster planci occurred in 2009 on the leeward side of the island and it disparately affected the coral cover of protected and non-protected sites with the protected sites losing 32.040% of their coral cover and non-protected sites losing only 1.243% of their coral cover from 2009 to 2010. On the windward side of the island where there was not an outbreak of A. placi the coral cover increased by 10.024% from 2009 to 2010. Through further analysis of the regulatory regimes the recommendation is made to impose stricter fishing regulations and more vigorous A. placi management with the goal of allowing the natural ecosystem time to rebound.

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FORGING PARTNERSHIPS TO LAY A FOUNDATION FOR ENVIRONMENTAL SUCCESS (Abstract ID: 29626)

The marine environment and the incomes of coastal communities in the Eastern Caribbean (EC) have benefited from partnerships established at the national and regional level under the Eastern Caribbean Marine Managed Areas Network (ECMMAN) project. 5 regional and international organizations with varying mandates in collaboration with governmental and non-governmental organizations in 6 EC countries have unified as one implementing unit with the shared objective to create a network that more than doubles the area of effectively managed marine managed areas while providing for improved livelihood opportunities. In order to build an effective partnership, each organization brought complementary strengths that contributed to building an effective mechanism for project implementation. The organizations 7 collective core areas of strength are local knowledge and experience, environmental policy, scientific research, training and education,sustainable financing, and public awareness and outreach. Some lessons learned from this collaboration included the need to: establish ground rules from the start, establish clear and open channels of communication, clearly define roles and responsibilities, immediately resolve issues, respect each other's organizational norms, and think outside of the box for creative solutions to problems. These collaborative actions have resulted in a uniquely strong, effective, nimble partnership that benefits conservation and management of the marine and coastal resources across organizational missions and international boundaries.

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NOT ALL CORALS DINE IN: VARIATION IN NICHE PARTITIONING BETWEEN CORALS AND THEIR *SYMBIODINIUM* INDICATES A RANGE OF SYMBIOSES (Abstract ID: 29304)

The symbiosis between corals and *Symbiodinium* has allowed coral reefs to achieve high levels of productivity and diversity in oligotrophic habitats. By sharing resources, corals and *Symbiodinium* access novel niche space. Some have argued that the coral-algal interaction ranges from mutualism to parasitism. Trophic niche theory predicts that mutualist symbionts would occupy the same niche space as their host (shared resources) whereas commensal symbionts would occupy a different niche (fewer shared resources). To test this hypothesis, we measured the $\delta^{13}C$ and $\delta^{15}N$ of separated coral tissue and symbiont cells from 6 coral genera commonly encountered in Hong Kong. Using Stable Isotope Bayesian Ellipses in R (SIBER) analysis, we compared the isotopic niche placement and area of each host and symbiont pair. Our results supported the hypothesis: in some genera (*Acropora* and *Goniopora*) the host and symbiont had nearly 100% overlap of their isotopic niches implying shared nutritional resources, while in others (*Platygyra* and *Favites*) there was no overlap. Finally, some genera (*Pavona* and *Porites*) have partial overlap suggesting a flexible symbiosis. These patterns were driven by nitrogen, not carbon. Indeed, the difference between the $\delta^{15}N$ values of host and symbiont was positively correlated with calyx volume, suggesting that smaller polyps evolved to support obligate symbioses while larger polyps enable corals to meet their nutritional requirements through alternative means.

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DEVELOPING A CONCEPTUAL MODEL FOR CORAL REEF MONITORING IN THE MEXICAN MESOAMERICAN BARRIER REEF SYSTEM (Abstract ID: 29897 | Poster ID: 523)

The Mesoamerican Reef System (MRS) is the second longest barrier system in the world and provides a variety of ecosystem services to adjoining nations. Ecosystem services include e.g. shelter from tropical storms, reef fisheries, and a wealth of biodiversity, a prosperous tourism industry or the provision of building materials. Besides global stressors (e.g. global warming and climate change, pollution, and others) it experiences a range of local stressors (e.g. land-derived eutrophication and sedimentation), particularly at the Mexican coast. The absence of effective MRS monitoring systems has been a limitation for its conservation. Conceptual models are a key element of coral reef monitoring programs since they integrate current understanding of system dynamics, identify important processes, facilitate communication of complex interactions, and illustrate connections between indicators and ecological states or processes. Well-constructed conceptual models provide the scientific framework for monitoring programs and the justification for the choice of indicators. This poster contribution presents the design of a management-targeted conceptual model that can facilitate conservation of the MRS. It thereby uses an innovative approach to fill the knowledge gaps of linking both types of reef data: reef field assessments and remote sensed data. The proposed model not only links scales and spatial dynamics, but also highlights main local impacts. From this perspective, the conceptual model to monitor the MRS will support decision makers to implement strategies for improved management, and to identify and prioritize the more changing and affected components.

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MITIGATING PRESSURES IN HIGH TRAFFICKED AREAS USING CUSTOM DESIGNED REEFS (Abstract ID: 27842 | Poster ID: 468)

Where diving and coral reef tourism are particularly intense, the ecosystems are often overexploited and seriously degraded. On the island of Koh Tao, in the Gulf of Thailand, we have been developing custom designed reefs as alternative centres for tourism focus and ecosystem rehabilitation. Koh Tao entertains upwards of half a million visitors per year on a 21 km2 island. Much of the degradation is attributable to excessive numbers of poorly managed divers and snorkelers and the consequences of their visitation. Zoning plans and user guidelines help but limited resources for policing and enforcement have lead to the need for reef restoration programs and the development of artificial reef. Research

has shown that these locations assist in mitigating pressure and providing ecological solutions to localised reef degradation. Further they enhance awareness of conservation issues across a broad spectrum of the stakeholders from visitors, to local residents and government officials. Research also highlights the ecological value artificial reefs can have on marginalised reef communities. The development of artificial reefs on Koh Tao has been enacted primarily without external funding support and provides a template for use in other locations where resources, especially financial, are limited but willingness is high.

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ACTIVE REEF RESTORATION: IMPROVING THE OUTCOME FOR DEGRADED REEFS IN THAILAND (Abstract ID: 27783)

The threatened ecosystems of coral reefs are particularly vulnerable in those locations where anthropogenic pressures are acute. On the island of Koh Tao, in the Gulf of Thailand scuba diving and coral reef related tourism places ever increasing pressure on the fragile reefs that surround this 21km2 island. Conservation groups in collaboration with local businesses, universities, scientists, government officials and community groups implement a range of reef restoration tools and activities that aim to increase the resilience of the reefs around the island. Using coral and giant clam nurseries, artificial reefs and a suite of monitoring tools conservation has developed into a mainstay of the economic model of this scuba diving dependent location. Developing artificial reefs combined with active reef restoration has released pressure from vulnerable natural reefs. These artificial locations allow opportunities for novel and innovative reef restoration techniques while providing welcome respite for overexploited reef environments. We explore the potential for truly community based tourism and conservation groups to develop these multi faceted targeted artificial reefs to ecologically support the recovery of natural reefs in this heavily perturbed environment.

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CHARACTERIZING BENTHIC INVERTEBRATE COMMUNITIES OF THE SOUTH TEXAS BANKS (Abstract ID: 28993 | Poster ID: 327)

The South Texas Banks (STBs) are a rare hard bottom feature of the Gulf of Mexico (GOM) colonized by a community of deep water corals whose multi-species, high-density assemblages provide structurally complex habitat and significant ecosystem services. The depth of the banks, a persistent nepheloid layer, and strong currents have hindered efforts to collect quantitative data on what inhabits the rocky outcrops and relic coralgal reefs. The STBs were under consideration as a candidate for Marine Protected Area (MPA) status in 2008, but there was not enough information available to support this conservation action. Using a remotely operated vehicle, video data from 5 banks were collected in order to characterize the benthic communities. Community structure analyses show significant differences in benthic community composition between the two southern and the three northern banks surveyed. Also, by correlating the benthic communities' data with terrain patterns from multibeam sonar images, a habitat suitability model was created to predict the probability of presence of important coral species. This work significantly reduces the cost, time and effort in characterizing the banks, which is key to ensuring that these habitats are protected. The ability to create habitat suitability maps and discern biodiversity of the South Texas Banks from multibeam SONAR images will aid future marine protection efforts in the Northwestern GOM.

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INTEGRATING KNOWLEDGE FROM SHALLOW REEFS, THE MESOPHOTIC ZONE AND CHARISMATIC MEGAFAUNA IN THE CONSERVATION OF A WORLD HERITAGE AREA: NINGALOO OUTLOOK PROJECT (Abstract ID: 29149)

Ningaloo Reef Marine Park, declared a UNESCO World Heritage Area in 2011, has unique biodiversity values, abundant marine life and is the only fringing coral reef on the west coast of a continent in the world. Much remains unknown about the reef and its inhabitants, with most research focusing on single elements and missing interactions in this complex ecosystem. A strategic research partnership between BHP Billiton and CSIRO is gathering new knowledge on shallow and deep water habitats, and shark and turtle populations to better equip those responsible for the conservation and management of the marine park. This talk will present an overview of the key objectives of the three research themes, and findings to-date: i. Deep Reefs research documenting the extent and character of deep water habitats; ii. Shallow Reefs gathering knowledge to better understand the ecological processes that are important in the structuring of reef flat and reef slope communities; and iii. Tagging to provide fundamental information needed to understand the ecology of sharks and turtles. The program will also provide information on interdependencies among different parts of the reef as well as long-term trends in corals, fish and iconic megafauna. A key component of the partnership is the engagement of local community members who have become ambassadors of the project. PhD scholars are also embedded in each research theme to provide training for the next generation of scientists. An overview of the community engagement program including those established in local schools will be presented.

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MACROECOLOGICAL PATTERNS OF SEA URCHINS SPECIES IN SHALLOW REEF ENVIRONMENTS (Abstract ID: 28724)

Sea urchins are known to greatly influence benthic communities, mainly by controlling algal cover, both in tropical and temperate reefs. Despite this importance, there is a knowledge gap concerning their macroecological patterns. The relative importance of sea urchins on the dynamics of benthic cover may vary locally and regionally due to functional redundancy and relative abundance of species. In order to assess diversity patterns of sea urchins in tropical and temperate reef systems, we analysed a compilation of open databases, published and unpublished data. Regular sea urchin species occurring above 100m were selected for the analysis, consisting of 175 species (15 families, 7 orders). Tropical reefs from the Central Indo-Pacific showed highest species richness, longitudinally decreasing towards the west. Species richness decreased from low to high latitudes, similarly to patterns found for reef fishes and mollusks. Provinces of the Central and Western Indo-Pacific showed the highest levels of endemism, and the least structured data in ordination analysis. Temnopleuridae was the most speciose family, but Cidaridae was the most widespread globally. The wide latitudinal range of Toxopneustidae and Diadematidae species – often associated with urchins' blooms and barren formations – may indicate potential higher resilience of these taxa on tropical reefs. Macroecological patterns of species richness associated to functional diversity may help to explain known spatio-temporal variabilities of sea urchins, and its potential effects on high versus low diversity regions.

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CONTROLS OF CORALLINE ALGAL CALCIFICATION: ROLE OF INTERNAL PH IN INFLUENCING RESPONSES TO OCEAN ACIDIFICATION AND OTHER ENVRIONMENTAL VARIABLES (Abstract ID: 28055)

Coralline algae are important in forming/binding reefs and provide a settlement substrate for many valuable species (e.g. abalone, corals), but are susceptible to ocean acidification through declines in net calcification rates. However they exhibit large variation in their responses, some of which could be explained by their physiology. Integral in the response of coral net calcification to ocean acidification is the capacity to elevate the pH of the calcifying fluid (pHcf) at the site of calcification; it is unknown whether the same principle applies to coralline algae. We ask: 1) do coralline algae elevate pHcf at the site of calcification in the cell wall; 2) how are changes in net calcification rates of coralline algae under OA related to changes in seawater pHT and calcifying fluid pHcf, and 3) what role does latitude, species, and wave exposure play in influencing pHcf and how is this related to net calcification? We examined the responses of net calcification and pHcf to ocean acidification, and compared pHcf with net calcification rates from the field for different species from various latitudes across a range of wave exposures. We find the majority of coralline algal carbonates have high $\delta$11B values (25 to 34 ‰), implying high pHcf values (>8.5) if only the tetrahedral B(OH)41- is incorporated. However, coralline algae precipitate calcite, rather than aragonite like shallow water corals, meaning high $\delta$11B trigonal B(OH)3 may also be incorporated. We also discuss how coralline calcification rates relate to pHcf from the field and under elevated CO2.

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A COMPARISON OF STAGHORN CORAL FECUNDITY AND SPAWNING OBSERVATIONS FOR WILD, OUTPLANT, AND NURSERY COLONIES (Abstract ID: 28806 | Poster ID: 490)

The staghorn coral (Acropora cervicornis), a foundation species on Greater Caribbean coral reefs, has experienced population declines to a level where natural population

recovery is uncertain. With a listing of Threatened under the US Endangered Species Act, A. cervicornis has been identified as a high priority species in need of active population restoration efforts. Nurseries have been identified as a productive restoration method by increasing colony abundance and by reducing the spatial gap between populations, increasing the likelihood of successful sexual reproduction. The survivorship of outplanted colonies has been well documented; however their sexual reproductive capacity is not fully understood. We are addressing this information gap by comparing histologically derived gamete abundance and colony fecundity data with in-situ spawning observations for A. cervicornis wild colonies, outplanted colonies, and nursery colonies offshore southeast Florida. During 2014 wild colonies were highly fecund and mass spawned, outplant colonies had low fecundity and were not observed to have spawned, while nursery colonies were fecund and partially spawned. During 2015 wild colonies were fecund and partially spawned, outplant colonies had low fecundity and were not observed to have spawned, while nursery colonies were fecund and partially spawned. Stress associated with higher than average water temperatures in 2014 and 2015, colony ages, and colony fragmentation and transplantation history likely contributed to differences between colony types.

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BENTHIC DIVERSITY SPECIES IN TIDE POOLS FROM REEF PLATFORM ON THE MACEIÓ COAST, ALAGOAS STATE, BRAZIL. (Abstract ID: 29281 | Poster ID: 61)

The Brazilian northeastern coast has many coral and sandstone reefs, where the top reef platform remains exposed during low tides. This study analyzed the diversity and distribution of benthic species in tide pools on the Sereia sandstone reef, coast of Maceió, Alagoas, Brazil. During two low tide periods in November 2015, by visual recordings, on 12 tide pools were analyzed the sessile and sedentary organisms by coverage percentage, and when necessary some specimens were collected for taxonomic confirmation in the laboratory. All tide pools were measured length, width and depth to include in smaller and bigger size. The water abiotic aspects were obtained to each tide pool studied including temperature, pH and salinity. The software Past 2.17 was used to calculate the diversity data to richness, Shannon index and evenness. Linear regression was obtained with the same program. In this study, 27 taxa of macrobenthic organisms were recorded including: 4 Chlorophyta, Rhodophyta 2, 6 Phaeophyta, 3 Porifera, Cnidaria 8, 2 Mollusca and Echinodermata 2. The results for the linear regression showed that the depth had a significant relationship with richness ($r = 0.82$; $p < 0.005$) and Shannon index ($r = 0.82$; $p < 0.005$). The data obtained for the tide pools indicated the depth as the main factor that influenced positively the richness and diversity of species. This was probably because the depth inside the tide pools protects the macrobenthic species from the impacts and stress caused by exposure during the low tides and by the brake waves associated with the high hydrodynamics local.
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VISUAL EVOLUTION: LESSONS LEARNED FROM 100 FISH GENOMES (Abstract ID: 29528)

Imagine living a thousand meters below sea level surrounded by darkness but for a few bioluminescent rays of light. Now imagine living in a clear mountainous lake three thousand meters above sea level where the plethora of light can cause blindness anytime. There are many examples of animals that have adapted their vision to cope with different light conditions, yet little is known about the molecular basis of these adaptations. Thanks to recent technological advances, it has now become feasible to study the evolution and function of vision, along with its underlying molecular machinery (opsins and the visual pathway genes), one-on-one, in nature. Here, we report the evolutionary history of opsin genes based on the comparison of 100+ genomes and 40 transcriptomes spanning the teleost fish phylogeny. We show that the evolutionary history of opsins is very dynamic, involving frequent duplications but also gene losses that correlate with the light environment of different species. In particular, several deep-sea fish lineages have evolved ingenious strategies to adapt to the extremes of their photic environments, including one case of multiple rhodopsin duplications, which may well be the first evidence for rhodopsin-based color vision in vertebrates. Understanding how fishes perceive their world and how this allows them to adapt to different environments is crucial for future management purposes, especially since many fish species are facing imminent danger due to anthropogenic activities.

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THE OUR FLORIDA REEFS COASTAL USE SURVEY: AN ONLINE SURVEY TO SUPPORT STAKEHOLDER MANAGEMENT RECOMMENDATIONS FOR SOUTHEAST FLORIDA (Abstract ID: 30172 | Poster ID: 591)

Coral reefs are an important resource world-wide. Unfortunately, coral reef conditions are declining in many areas due to both global and local stressors. The objective of this study was to survey stakeholders in southeast Florida to better understand reef use in the region. Stakeholders spatially identified where and how often they conducted their activities. These data were compiled and analyzed in GIS to determine spatial use patterns. Both location and intensity of use were analyzed to determine which areas may be under greater stress from recreational activities. It was found that reef use was not evenly distributed in the region, but clustered around inlets and piers. Reef use differed between user groups (i.e. SCUBA divers, fishers) and demographics. It was also found that use in the Broward-Miami Coral Reef Ecosystem Region was spread out over a wider spatial scale than the use in the regions north and south. These data are important as they have the potential to inform the recommendations being made to improve coral reef management in southeast Florida. The study can provide a better understanding of human-environmental relationships and the trade-offs involved so that recommendations can better decrease user conflicts, maximize economic productivity, and preserve the environment.

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CAUSES AND CONSEQUENCES OF THE 2014 MASS BLEACHING EVENT IN PAPAHANAUMOKUAKEA MARINE NATIONAL MONUMENT (Abstract ID: 29602)

2014 marked the third reported mass bleaching event in Papahānaumokuākea Marine National Monument (Northwestern Hawaiian Islands), which is one of the world's largest marine reserves. Warming began in the central islands in late August 2014 and extended to northern atolls by early September. Cumulative thermal stress from satellite-derived temperature data ranged from 7 degree C weeks at French Frigate Shoals to 15 degree C weeks at Lisianksi Island by October 30th. To assess the temporal patterns in bleaching and resulting mortality, we surveyed permanent sites at French Frigate Shoals (FFS), Lisianski Island (LIS), Pearl and Hermes Atoll (PHR), and Midway Atoll (MID) in September 2014 and August 2015. In 2014, the mean % of severely bleached corals was 8, 22, 37 and 45% at FFS, PHR, MID and LIS, respectively. Mean % of severely bleached corals increased moderately and significantly with sustained high temperatures, but varied among habitats with shallow forereefs surrounding LIS and backreefs at PHR and MID most affected. While Montipora spp. were most affected, this event was unlike previous events due to widespread bleaching across 22 species. In August 2015, we did not observe widespread bleaching or thermal stress. While corals in certain regions demonstrated recovery and minimal mortality, mean % coral cover at permanent sites decreased by 68% at LIS. 3D reconstruction techniques were also used to assess the impact of bleaching-induced mortality on habitat structure. Coral mortality directly correlated with reductions in both habitat complexity and volume.

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UNDERSTANDING THE CONSEQUENCES OF LAND-BASED POLLUTANTS ON CORAL HEALTH IN SOUTH KOHALA, HAWAI'I (Abstract ID: 30045)

Increasing human populations in Hawaii's coastal regions combined with ineffective land use practices has resulted in deteriorated water quality and impaired reef health through-

out the state. Land-based pollution is of particular concern in Puakō, Hawai'i Island due to land use change, strong evidence of sewage pollution, and a 50% decline in coral cover during the last 40 years. In this study we: 1. identified 12 sites across regions of low to high terrestrial input and characterized spatial patterns in nutrients, fecal indicator bacteria, and coral health; 2. tested the correlation between coral health and environmental metrics using mixed modeling; and 3. prioritized reef areas that may benefit from corrective action. Nutrient concentrations and fecal indicator bacteria abundance were highly variable across the study region, but were elevated in shoreline areas and declined reefward, confirming the presence of land-based inputs. Coral health was also highly spatially variable with the most prevalent conditions being growth anomalies and algal overgrowth, each affecting 20% of colonies. Nutrient concentration was the strongest environmental predictor of coral health, with a higher prevalence and severity of growth anomalies in regions with elevated nitrate + nitrate concentrations. Our study highlights that nutrients that can be associated with sewage or other sources are linked with impaired coral health, and that coral health should be integrated into management plans as a tool for identifying impaired reefs and understanding how watershed inputs affect reef health.

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SPATIAL AND TEMPORAL PATTERNS IN BIODIVERSITY: A LOOK AT CRYPTIC CORAL REEF COMMUNITIES ACROSS THE HAWAIIAN ARCHIPELAGO (Abstract ID: 29330)

Ecosystem function and resilience are fundamentally connected to patterns in community composition. The goals of this study were to document spatial and temporal patterns in reef biodiversity, to identify correlations between community composition and environmental variables, and to investigate trends in species co-occurrences. This work focused on communities of semi-cryptic fishes and invertebrates closely-associated with Pocillopora meandrina. Communities were surveyed in >1500 P. meandrina colonies across 44 sites in the Hawaiian archipelago. Preliminary analyses suggest lower biodiversity within the highly protected Papahānaumokuākea Marine National Monument than around the densely populated island of O'ahu. Across all sites, characteristics of the host colony (e.g., coral size, percent live tissue) were highly correlated with community composition. Species co-occurrence analyses identified far more positive than negative species pairs with some noteworthy exceptions; e.g., one common species of guard crab had only negative species associations. To quantify temporal variability, communities within 20 P. meandrina heads were followed monthly at two sites for 20 months. There was lower species turnover within communities over time than between communities over space. The largest temporal shifts occurred within colonies that had recently bleached or were becoming covered with algae. Our results suggest that biodiversity in P. meandrina-associated communities is influenced by regional differences along the Hawaiian archipelago, host coral quality, and species interactions.

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MAPK SIGNALING IN CORAL STRESS RESPONSE (Abstract ID: 27820)

Coral reefs are of major ecological and socio-economic interests. They are exposed to a variety of anthropogenic stresses such as ocean acidification and global warming, in addition to natural stresses such as excessive solar irradiance and UV radiations. In the context of climate change, great efforts are made to try to predict and prevent coral reef degradation in response to stresses. Yet, very little is known about the signaling pathways involved in the immediate stress response of these organisms. We identified c-Jun N-terminal Kinase pathway (JNK) as being responsive to thermal and UV stresses. In particular, JNK is activated when corals are exposed to high temperature (30 °C) with or without UV radiations. Using a specific inhibitor, we showed that JNK is required for corals to down-regulate temperature and UV-induced reactive oxygen species production. A comparable phenomenon was observed in human fibroblasts exposed to the same stresses. Together, our results show that an ancestral stress response pathway involving JNK is conserved from corals to mammals to protect cells from adverse events induced by temperature and UV stresses.

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CHANGES IN THE INTENSITY OF DAMSELFISH ALGAL GARDENING IN BOCAS DEL TORO, PANAMA OVER 7000 YEARS (Abstract ID: 29927 | Poster ID: 3)

Damselfish (Pomacentridae) often engage in a mutualistic behavior of plant-herbivore gardening with filamentous algae. Fish deliberately damage patches of coral, permitting space for the colonization of algae, which they then "farm". In response to the bites of damselfish, the staghorn coral,*Acropora cervicornis*, produces distinct protuberances, or "chimneys". These chimneys preserve well in fossil corals enabling a quantitative analysis of chimney frequency between fossil and modern *A. cervicornis* assemblages. Using modern and 7000 year old corals from Bocas del Toro, Panama, we found that the occurrence of chimneys on coral branches is twice as frequent today as it was 7 ka, and that the maximum density of chimneys in modern reefs is 10 times greater than it was 7 ka. These data indicate that a significant shift has taken place in the interaction between damselfish and staghorn coral over the last 7 ka. Possible causes include: (1) A change in the relationship between fish, coral, and algae, (2) More damselfish per coral caused by release from predation by overfishing, (3) More damselfish per coral caused by a reduction in the abundance of living A. cervicornis, (4) A decrease in the growth rate of *A. cervicornis* resulting in an apparent increase in chimney density. Further work is needed to quantify natural variation in chimney density, understand the process of chimney formation, and expand the fossil sampling.

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COMPARING CHEMISTRY AND CENSUS-BASED ESTIMATES OF NET ECOSYSTEM CALCIFICATION ON A RIM REEF IN BERMUDA (Abstract ID: 29793)

Coral reef net ecosystem calcification (NEC) has decreased for many Caribbean reefs over recent decades primarily due to a combination of declining coral cover and changing coral reef community composition. Chemistry-based approaches to calculate NEC utilize the drawdown of seawater total alkalinity (TA) between the reef environment and offshore waters to calculate an instantaneous measurement of NEC. Census-based approaches combine annual growth rates with benthic cover and reef structural complexity to estimate NEC occurring over annual timescales. Here, we calculated NEC for Hog Reef in Bermuda using the chemistry and census-based NEC procedures to compare the mass-balance generated by the two methods. NEC was calculated via the chemistry-based approach using reef TA data from a carbonate chemistry monitoring project and offshore TA data collected by the Bermuda Atlantic Time-Series Study. To calculate NEC with the census-based approach, we used benthic surveys of line transects conducted at Hog Reef coupled with literature reported mean annual coral growth rates aggregated by the *ReefBudget* project, in-situ growth rates of *Porites astreoides* and *Diploria labyrinthiformis* during the time of the study, carbonate sediment dissolution rates from benthic chamber experiments, and photographic measurements of reef rugosity. Our initial findings indicate the annual mean NEC calculated by the two methods agrees within the range of uncertainties and highlights the high temporal variability of reef NEC in response to changing environmental conditions.

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PREDATION ON CROWN-OF-THORNS STARFISH LARVAE BY DAMSELFISHES (Abstract ID: 27890)

Examining the functional response of predators provides insight into the role of predation in structuring prey populations and ecological communities. We explored feeding behaviour and functional response of planktivorous damselfishes when offered captive reared larvae of crown-of-thorns starfish, Acanthaster spp. with the aim of determining whether these predators could play a role in moderating outbreaks of Acanthaster spp. With 11 species of planktivorous damselfish, we tested: the relationship between predator size and predation rate, both within and among fish species; consumption rates on larvae of Acanthaster spp. vs. larvae of a common, co-occurring asteroid Linckia laevigata; maximal feeding rates upon both Acanthaster spp. and L. laevigata; and functional responses of planktivorous fishes to increasing densities of Acanthaster spp. This data revealed that a wide range of planktivorous fishes prey upon larvae of Acanthaster spp. Consumption rate of Acanthaster spp. larvae by damselfishes was independent of predator size, however there was a significant negative relationship between predator size and consumption rate of L. laevigata, when pooling across all predatory species. Two species, Acanthochromis polyacanthus and Amblyglyphidodon curacao, consumed larval Acanthaster spp. at a greater rate than they consumed L. laevigata. Most fishes exhibited a Type II functional response, suggesting that they may have the capacity to buffer against population fluctuations of Acanthaster spp., however abnormally high larval influx may swamp these predators, potentially contributing to the characteristic population fluctuations of Acanthaster spp.

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INVESTIGATING MULTIPLE CORAL REEF STRESSORS ON A SHOE-STRING (Abstract ID: 29324)

The decline of reef health and resilience has been recorded in many locations, but the causes of this decline are less clear. The ecologically complex and dynamic nature of coral reefs means that identifying the factors contributing to coral decline is difficult, and requires measuring numerous indicators. In this study, indicators of reef resilience to coral bleaching were collected on 40 different sites in Kenya, Mozambique, Maldives and Sumatra. All parameters used in this study were collected either during a single visit to the reef or from freely available online data sources. The resilience of these reefs in terms of recovery potential and resistance to bleaching were compared with five explanatory factors, intended to encompass a range of human stressors, past climatic stress and natural variation in resilience: local human population density, distance to the mainland, past acute thermal stress, protected status and reef zone. Local population, distance to the mainland and zone were significantly correlated with reef resilience. Reefs with the highest recovery potential were associated with low population densities, and offshore locations. Sites with the highest resistance were in lagoons and nearer to the mainland. This study demonstrates how multiple stressors on coral reefs can be investigated and analysed using minimal resources. The findings of this study point towards conservation actions, including the prioritisation of protecting Enggano, Sumatra, as an MPA, and boosting resilience in Vamizi, Mozambique, through increasing herbivore biomass.

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CONNECTIVITY OF THE PULLEY RIDGE - SOUTH FLORIDA CORAL REEF ECOSYSTEM: PROCESSES TO DECISION-SUPPORT RESOURCES (Abstract ID: 29838)

The coral reef ecosystem of the southeast United States is a complex system of interconnected, deep and shallow reefs stretching along the western, southern and southeastern coasts of Florida. Given its economic and ecological value, there is a strong need to develop effective management options that encompass the entire ecosystem and its complex interactions. The goal of the Pulley Ridge research program is to provide the key scientific information needed to rigorously address this management challenge with a specific focus on the mesophotic reefs located on Pulley Ridge. We adopt an interdisciplinary approach (physical oceanography, bio-physical modeling, population genetics, population dynamics of key species) and yield a quantitative understanding of the scale and extent of connectivity. Building on this information we then incorporate studies on the community structure and valuation of ecosystem services (e.g., fisheries) to further refine management options and help establish priorities. Through consultation with state, federal and private stakeholders, we are integrating our findings into a Decision Support Resource to aggregate findings and archive data.

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TEMPORAL PATTERNS OF ENDEMISM AND PROVINCIALITY IN TROPICAL REEF FISHES (Abstract ID: 29433)

There is a general consensus that a large marine biodiversity hotspot straddles the Indian and Pacific Oceans. Centered on the Indo-Australian Archipelago, this biodiversity hotspot forms a steep gradient in species richness from this center to the periphery. This gradient is characterized by over 5000 species of reef fish. Yet the origins of this pattern and how it is maintained across two-thirds of the world's oceans remains unclear. Traditional 'hotspot' assessments based on endemism have had little success, with areas of species richness decoupled from centers of endemism. While there is a gradient in species richness across the Indo-Pacific, provincial schemes have been identified based on numerous delineating criteria. But, so far these delineations have not accounted for the phylogenetic and biogeographic history of taxa. Here, we present an overview of the origin of endemism in reef fishes, and combine ancestral biogeographic estimation and phylogenetic dissimilarity clustering methods to explore past and present provinciality. While phylogenetic sampling of endemism is low, most ecoregions contain both old and young endemic species. Phylogenetic dissimilarity clustering of extant assemblages identifies a large Indo-West Pacific cluster, but also clusters distant Pacific island together based on peripherally isolated, but phylogenetically close lineages. Through time, clustering of estimated ranges reveals the dynamic nature of reef assemblages with provincial changes reflecting large scale tectonic rearrangement of the tropical belt.

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THE ROLE OF REEF COMMUNITY COMPOSITION AND PARROTFISH PROTECTION IN PHASE SHIFT REVERSAL (Abstract ID: 30034)

Protecting parrotfish species from fishing is a central conservation strategy designed to reverse shifts in reef community structure from coral to algal dominance. However, the response of reef communities might not be that simple. Here we evaluate the response of parrotfish populations and benthic communities to protection from marine protected areas and a national ban on herbivorous fish harvesting. From 2009 to 2013, we annually surveyed 16 reefs in Belize, including 8 MPA sites (Fully Protected or General Use), and 8 unprotected control sites. At the reefs surveyed, macroalgal communities were dominated by Lobophora sp., Dictyota sp. and Halimeda sp. and parrotfish communities were dominated by Sparisoma viride and Sparisoma aurofrenatum. Parrotfish biomass increased in protected zones over the five-year study period; however, recovery in Belize has not followed the trajectory of other regions of the Caribbean. The increase in S. viride and S. aurofrenatum was relatively greater in the General Use zone, which corresponded to reductions in Dictyota sp. and Halimeda sp, but not Lobophora sp. We found no relationship between mean parrotfish biomass and mean macroalagal cover across all sites and year. Additionally, mean total macroalgal cover remained above 40% in all years suggesting that the amount of macroalgae on Belizean reefs may simply be greater than the consumption capacity of herbivorous fishes. We suggest that protection of parrotfish may not be a panacea and community composition is an important consideration for the success of phase shift reversal.

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SOCIAL FRAGMENTATION INHIBITS LOCAL MANAGEMENT IN A DOMINICAN FISHERY (Abstract ID: 28831 | Poster ID: 597)

Like many artisanal fishing communities around the globe, the village of Buen Hombre in the Dominican Republic is struggling to sustainably manage its coral reef fishery. An effective local management regime reported in the community in the 1980s and 90s has since deteriorated, and the present-day marine ecosystem indicates heavy overfishing. We integrate current and historical data to assess social changes within the Buen Hombre fishery and their implications for current fishing practices. Our findings indicate that an increase in social divisions among the Buen Hombre fishers poses a significant barrier to management in the community today. We conduct social network analyses to measure unity among the Buen Hombre fishers and identify factors contributing to social fragmentation. These analyses reveal strong social divides among the Buen Hombre fishers and indicate that choice of fishing gear and membership to the Buen Hombre Fishermen's Association are key drivers of these social factions. Our analyses also enable us to identify key individuals within the community that have high degrees of social connections within or between different social subgroups. Reestablishing local management of the Buen Hombre fishery will require communication and cooperation among the entire fisher population. Social network analyses provide invaluable insight for bridging social factions and facilitating effective management not only in Buen Hombre but in artisanal coral reef fisheries around the world.

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PROJECT CORAL – DEVELOPING PROTOCOLS FOR PREDICTABLE BROADCAST CORAL SPAWNING IN CAPTIVITY (Abstract ID: 28671)

While brooding coral species commonly release planula in aquaria, broadcast spawning events in captivity are rare and highly unpredictable. Spawning correlates strongly with a number of environmental signals, (seasonal temperature, lunar and diel cycles) however few robust experimental studies have examined the role of these putative cues in triggering spawning. Project Coral, an innovative coral sexual reproductive research project, run by the Horniman Museum and Gardens, London, in collaboration with S.E.A Aquarium, Singapore and SECORE International aims to better understand the drivers of coral reproduction and to develop protocols to facilitate predictable broadcast spawning events in captivity. In March 2015 14 large *Acropora hyacinthus* fragments were transported from a reef off Singapore to the Horniman in London. Corals were kept in a microprocessor controlled aquarium to replicate conditions on their native reef (i.e., seasonal temperature, photoperiod and lunar cycles). Collection was purposefully timed to occur 1 month before the predicted annual mass spawning event to initially to see if spawning timing would remain in synchrony with the remnant parent colonies from which the fragments were removed. In April 11 of the 14 corals spawned in the tank at approximately the same time as corals remaining on the reef demonstrating that natural rhythms had been maintained. The long term aim is to see if we can maintain spawning rhythms over longer periods and ultimately manipulate environmental signals to investigate their role in triggering spawning.
http://www.horniman.ac.uk/projectcoral

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PREHISTORICAL AND HISTORICAL DETERIORATION OF CARIBBEAN REEF ECOSYSTEMS LINKED TO DECLINES IN REEF ACCRETION, HERBIVORY, AND WATER QUALITY (Abstract ID: 30050)

Caribbean reefs have declined dramatically over the past decades, suffering mass mortality events that have transformed them from coral- to algae-dominated habitats. Debate is ongoing about the initial timing and dominant drivers of recent change due to lack of baseline data. To help resolve the underlying mechanisms of recent and widespread reef declines, we produced a high-resolution 3,000 year record of reef ecosystem state from the analysis of fish, coral, urchin, bivalve, and benthic foraminifera subfossils within reef matrix cores from Caribbean Panama. This whole-ecosystem approach allowed us to determine ecological linkages among different faunal groups and to infer environmental causes and consequences of observed community change. At each site, declines in reef accretion rates and fish and coral abundance were initiated in the prehistorical or historical period, characterized by remarkably consistent patterns of change in fish, urchin, and bivalve composition. Historical ecosystem shifts were accompanied by a decline in water quality, implicating local human activities. Accretion rates were tightly coupled with parrotfish and urchin abundances throughout the cores. Our results suggest close integration of multiple components of the reef community, suggesting feedbacks between corals and herbivores in particular are making it difficult to reverse reef phase shifts.
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DIVERSITY OF THE INDO-PACIFIC NETWORK: INSIGHTS INTO LINKS BETWEEN GENETIC AND SPECIES DIVERSITY. (Abstract ID: 29110)

The tropical Indian and Pacific oceans form the world's largest and most speciose marine biogeographic region: the Indo-Pacific. Due to its size and political complexity, the Indo-Pacific is rarely studied as a whole, yet comprehensive studies of the region promise to teach us much about marine biogeography. Molecular methods can provide substantial insights into the processes that create and maintain biodiversity in the region. Although many research groups have independently amassed considerable genetic data much can be learned from capitalizing upon these efforts in a larger, unified, multispecies context. The Diversity of the Indo Pacific Network (DIPnet) seeks to promote open data exchange and collaboration among researchers working in the Indo-Pacific region; to this end, we have assembled the most extensive database of georeferenced mitochondrial DNA sequences for any biogeographic region comprising over 30,000 individual haplotypes from over 200 coral reef associated species sampled at over 1,500 locations. Initial analysis of the database reveals a significant correlation between coverage-corrected haplotypic richness and species richness. Moreover, bioregionalizations based on coral community composition explain genetic structure in a majority of tested species better than those based on fish. Both results suggest common mechanisms for structuring marine biodiversity at the molecular and species level. We will discuss these preliminary results and promote DIPnet as a vehicle for open science and international collaboration.
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PARTNERSHIP FOR SUCCESS IN A CHANGING SEASCAPE: COMBINING INDIGENOUS PRACTICES AND WESTERN SCIENCE FOR SUSTAINABLE REEF MANAGEMENT IN THE YAP OUTER ISLANDS (Abstract ID: 29987)

The Yap outer islands (Federated States of Micronesia) encompass more than 250,000 Km2 of the tropical western Pacific. Outer Islanders depend on their coral reefs for food and other environmental services, but cultural and ecological change are compromising the reef ecosystems. A lack of scientific knowledge from the region coupled with a decline in traditional management knowledge and frameworks have left communities with a lack of knowledge to effectively manage their reef systems in the face of rapidly changing ecological and social systems. In recognition of this, communities on Ulithi Atoll - the fourth largest atoll in the world, are working with a team of scientists to combine western science with traditional practices to address ecological and resource issues while strengthening communities and governance. It is a unique partnership to identify changes in resource extraction and management, and the impacts of those changes on the reef system–leading to depleted resources and in some cases poor reef health. Timely implementation of management has seen rapid results, and may well be key to reef recovery after the recent devastating typhoon Maysak. This successful model has inspired other outer island communities to model Ulithi, and has great potential to enhance adaptive management throughout the region. We will present findings from the science team, the fisheries data team (Ulithi science team), and how both western and indigenous teams are informing each other.
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DECIPHERING MULTIPLE CONTROLS ON CARBONATE CHEMISTRY IN COASTAL REEF SYSTEMS: AN EXAMPLE FROM A BACK REEF LAGOON WITH GROUNDWATER DISCHARGE (Abstract ID: 28908 | Poster ID: 95)

Understanding dynamic reef ecosystem processes is a critical step in determining he impacts of ocean acidification on coral reef communities. The Puerto Morelos coast of Quintana Roo, Mexico presents a unique opportunity to explore natural fluctuations in carbonate system parameters along the Mesoamerican Barrier Reef. Specifically, diurnal and seasonal patterns lead to natural fluctuations in community reef metabolism (respiration, photosynthesis, and calcification) that in this system are further complicated by the addition of brackish groundwater discharge into the back reef lagoon. We present data of from two instruments deployed over a period of six months to explore the relationships between physical and biological processes impacting carbonate chemistry on dynamic reef systems influenced by groundwater discharge.

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CARICOMP: TWENTY YEARS DESCRIBING PATTERNS AND TRAJECTORIES OF CARIBBEAN CORAL REEFS (Abstract ID: 28156)

Long-term monitoring programs are valuable to describe the natural dynamic of coral reef ecosystems in space and time. The Caribbean Coastal Marine Productivity program (CARICOMP) represents the largest and longest cooperative effort to monitor synoptically coral reefs in the Wider Caribbean. Here we present a summary of trajectories of 42 reef sites spread out across the region from 1992 to 2007. The analysis also includes few countries where the program is still active. Results indicate that in 1993, mean coral cover in the region was 21 ± 6 % (CI 95%). Only 11 sites (26%) had mean live coral cover above the regional average and remained in this way for the study period. In addition, ten sites (24%) were within the confidence interval of average live coral cover and kept this condition until 2007. More than 50% of the sites lost between 2 to 30% of their live coral cover from 1992 to 2007, with the largest coral mortality recorded at Morrocoy National Park (Venezuela) and Pinnacle reef (Cayman Islands). We found a weak but significant negative correlation ($r = -0.49$, $r2 = 0.19$, $p < 0.05$) between the mean live coral cover and mean macroalgae cover at all sites between 1993 and 2007. These results further indicate that lost of coral cover was not always followed by an increase of macroalgae. Overall, our results support that coral cover in the monitored Caribbean reefs had been declining over the past decades; however, degree of community structure change varied strongly across the 42 reef sites and relatively few showed a clear algal phase shift.

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HIGH THROUGHPUT MICROSATELLITE GENOTYPING CONTRADICTS THAT ACROPORA HYACINTHUS WAS EXTIRPATED ON PALAU AND RECOLONIZED FROM YAP. (Abstract ID: 29137)

The catastrophic loss of corals, particularly the Acropora spp., around the island of Palau following the 1998 El Niño had profound ecological and social impacts. The result of which included the formation of a network of marine protected areas (MPAs) with the goal of ensuring reef recovery and resilience to any such future events. MPA networks rely on population connectivity to persist, but measuring connectivity to support the design of MPA networks remains challenging because it is nearly impossible to track pelagic larval dispersal directly. A detailed oceanographic model, developed to evaluate the current MPA network design, predicts larval dispersal between Palau and Yap and led to the conclusion that recovery of Acropora spp. on Palau likely resulted from a pulse of larval recruitment from Yap. This result has been used to argue for cooperative MPA networks spanning Palau and Yap. We used high throughput microsatellite genotyping of the coral Acropora hyacinthus and show that recovery in Palau did not come from a pulse of recruits from Yap. Instead, we find as much differentiation within Palau as between Palau and Yap, with significant population genetic structure among all of the 25 sites sampled around Palau. These results indicate that recovery most likely originated, at least in large part, from sites within Palau, and suggest high rates of localized self-recruitment. In light of these results there seems to be little effective dispersal among sites around Palau, which argues for increasing the number and size of MPAs within Palau.

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"THIS IS WHO WE ARE": NATIONAL CAMPAIGN COMPETITION IN THE CARIBBEAN INCREASES COMMUNITY AWARENESS OF MARINE CONSERVATION AND MANAGEMENT (Abstract ID: 28977 | Poster ID: 608)

In 2015, six Eastern Caribbean islands competed to implement the most effective public awareness campaign that fosters pride in ocean resources and promotes environmental stewardship. The campaigns were an innovative strategy to address evidence of low support for marine managed areas (MMAs) among fishers and coastal communities. The initiative is a key component of the Climate-Resilient Eastern Caribbean Marine Managed Areas Network (ECMMAN). ECMMAN's goal is to build a network of effective MMAs in the region, which will protect critical ecosystems like coral reefs, and sustain healthy fisheries. Preliminary assessments in 2014 indicated more effectively managed MMAs will require increased public awareness to improve community acceptance and compliance. A campaign competition was designed to motivate community engagement, while maximizing regional impact through a shared campaign theme, "This is Who We Are." With regional training on campaign methodology and on-going support, marine resource representatives developed and implemented culturally relevant campaign strategies that targeted specific audiences, behaviors and outcomes. Campaign outputs include school presentations with mascots, beach clean-ups, fishing tournaments, music videos, radio shows and more. The campaign competition is a unique and successful model that can be replicated and modified both locally and internationally.

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LINKING PHASE SHIFTS TO ENVIRONMENTAL DIFFERENCES USING CORAL REEFS IN MARGINAL CONDITIONS (Abstract ID: 29601)

Phase shift, the change in dominance from corals to non-reef building organisms, is a dramatic consequence of coral reef degradation. Climate changes has been proposed to increase the frequency of phase shifts, leading to further loss of their ecosystem services. Higher resistance to climate changes has been theorized for reefs that formed in regions at the limit of tolerable environmental conditions (marginal reefs). Most previous phase shift assessments have been focused on non-marginal reefs, however, which could lead to potential bias in forecasts of the possible reef response to these environmental changes. Using datamining and meta-analysis, we examined the extensive marginal reef complex in the Southwest Atlantic to identify types of phase shift, the extent of their presence and also possible associations with natural and anthropogenic influences through statistical analysis. We used an index of phase shift through principal component analysis to define phase shift types and magnitudes for those previously studied reefs. Our results point two phase shift, one, more restrict, to dominance of zoanthid and another to dominance of macroalgae. Macroalgae phase shift is correlated with distance of coast and human density while zoanthid phase shift was found only on dredging influence areas. On Southwest Atlantic coral reefs, the sum of the proportion of reefs defined as exhibiting phase shifts was higher than for Caribbean reefs, suggesting that marginal reef are more sensitive to human impact and climate changes than non-marginal reef systems.

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GENDER-RELATED DIFFERENCES IN THE GROWTH CHARACTERISTICS IN SKELETONS OF THE REEF-BUILDING CORAL DICHOCOENIA STOKESI IN THE MEXICAN CARIBBEAN. (Abstract ID: 29699 | Poster ID: 385)

Mean annual growth characteristics (bulk density, skeletal extension rate and calcification rate) were determined using annual density growth bands found along slabs of skeletons of three females, and two males form the reef building coral Dichocoenia stokesi, collected at 4 m depth at Puerto Morelos Reef, Mexican Caribbean. No significant difference was observed for mean annual density between females and males (t-test for independent samples, $p > 0.05$). Annual skeletal extension and annual calcification rates showed a significant difference between both genders (t-test for independent samples, $p < 0.0001$). Despite these differences, for the time span represented by these slabs (1993-2013), calcification rate showed a negative relationship with increasing sea surface temperature (SST), decreasing around 0.19 g cm-2 yr-1 for each 1 oC increase in SST for both females and males. The slopes were not significantly different (F-test, $p > 0.05$) although the intercepts were significantly different (F-test, $p < 0.0005$). The intercepts indicated calcification would cease in females at 28.9 and at 29.9 oC in males. Similar to other coral species, the differences observed here in D. stokesi could be do to different energetic costs for reproduction between females and males, and must be taken into account when skeletons of gonochoric corals are used for environmental reconstructions.

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ECONOMICS, CONSUMER DEMAND, AND LOCAL ENVIRONMENTS INTERACTIVELY DRIVE CORAL-REEF FISHERIES EXPORTS ACROSS MICRONESIA (Abstract ID: 28425)

Coral-reef fisheries have historically played a central role in island societies, yet advances in fishing technology and growing commercialization are creating new and challenging fisheries paradigms. In Chuuk, Federated States of Micronesia, the combination of high unemployment, extensive coral reef systems, and proximity to the large commercial market on Guam has led to the development of the largest commercial reef fishery in the region. Export datasets revealed a fishery driven by foreign demand, with exports accounting for half of commercial landings over the last 12 years. Fishing effort matched Chuuk-Guam connecting flights, and exports became increasingly coupled with demand peaks associated with monthly disbursements of Guam's Supplemental Nutrition Assistance Program (SNAP). Large increase in SNAP issuance in the late 2000's corresponded with a "boom" of coral-reef fish exports, followed by a gradual decrease since 2010 that was associated with diminishing profits from rising costs and stagnating retail prices. While Chuuk stocks remain in better condition than other Micronesian jurisdictions,

strong gradients were found between catch success and proximity to human populations. Similarly, large-bodied species preferentially targeted for exports (but with little local demand) were most targeted and impacted by fishing pressure. Our findings suggest the need to transcend disciplinary and geo-political boundaries when managing small-scale fisheries in increasingly globalized markets.

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CELL TYPE-SPECIFIC TRANSCRIPTOMIC ANALYSIS ON *AIPTASIA SP.*(Abstract ID: 28662 | Poster ID: 15)

The symbiotic relationship between cnidarians and dinoflagellates forms the basis of coral reef ecosystems. Despite the ecological importance of this symbiosis, we know relatively little about the underlying cellular and molecular mechanism. The close relative of corals, the sea anemone *Aiptasia*, has been used widely as a model organism in the study of the cnidarian-dinoflagellate symbiosis. Like reef-building corals, *Aiptasia* establishes a stable symbiotic relationship with photosynthetic dinoflagellates of the genus *Symbiodinium*. However, in contrast to corals, *Aiptasia* can be maintained with or without symbionts and is easily kept and manipulated in common molecular biology labs. This makes it an ideal system to study the interaction of the partners in this symbiosis. To date, several publications have provided transcriptomic information for this model organism, but all the research was conducted on whole organism level. In this study, we applied laser microdissection to isolate endodermal and ectodermal cells from both symbiotic and aposymbiotic *Aiptasia*. We developed a protocol to extract RNA from this minute amount of cells and are in the process of generating tissue-specific transcriptomes and differential gene expression analyses for these four cells layers. This is the first study on cell type-specific transcriptome level in *Aiptasia* and the approaches we developed are expected to improve our understanding of the molecular and cellular basis of the cnidarian-dinoflagellate symbiosis.

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HETERARCHIES: CONNECTING HIERARCHIES AND NETWORKS FOR MARINE PROTECTED AREAS (Abstract ID: 27850 | Poster ID: 593)

Social-ecological systems research currently suffers from a disconnect between hierarchical (top-down or bottom-up) and network (peer to peer) analyses. The concept of the heterarchy unifies these perspectives in a single framework. I briefly review the history and application of 'heterarchy' in neuroscience, ecology, archaeology, multi-agent control systems, business and organizational studies, and politics. Recognising complex system architecture as a continuum along vertical and lateral axes ('decentralised vs. hierarchical' and 'individual vs. networked') suggests four basic types of heterarchy: egalitarian, polycentric, pyramidal, and individualistic. Each has different implications for system functioning and resilience, and systems may shift predictably and abruptly between architectures. I illustrate the value of this perspective using examples of institutional change in marine governance and differences in the ecological connectivity between reef ecosystems. Heterarchies suggest new ways of contextualising and generalising from case studies and new methods for analysing complex structure-function relationships.
http://www.coralcoe.org.au/researchers/gscumming

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SIMPLE DYNAMIC ENERGY BUDGET MODELS FOR CORAL-ALGAL SYMBIOSIS (Abstract ID: 29000)

Coral-algal symbioses are functional across a range of environmental conditions, yet show significant variation in architecture, mechanics, and performance as conditions change. A mechanistic understanding of dynamic coral-*Symbiodinium* interactions is necessary to understand and predict coral responses to environmental change. Dynamic Energy Budget (DEB) theory offers a framework to integrate effects of multiple abiotic factors on holobiont performance by tracking the flow of energy and mass through time within a syntrophic symbiosis. Here, we develop a simple DEB model describing the acquisition and exchange of carbon and nitrogen resources by both symbiotic partners based on the principle of sharing the surplus. The model qualitatively reproduces patterns in *Symbiodinium*biomass ratios and coral growth rates observed over a range of light, nutrient, and prey availability levels, suggesting the major mechanisms have been captured. The model can be expanded in a modular fashion to test hypotheses regarding how photoinhibition, host carbon-concentrating mechanisms, symbiont self-shading, nitrogen-recycling, or other phenomena influence symbiosis stability and coral performance under various conditions. Additional symbiont types may be modeled to test conditions under which symbiont shuffling occurs, and its effects on coral performance. DEB models may be used to generate wide-ranging hypotheses and predictions regarding coral-*Symbiodinium* symbioses, and may ultimately provide a mechanistic understanding of coral responses to environmental change.

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EMPIRICAL ASSESSMENT OF CLIMATE-INDUCED RANGE SHIFT IN AN ENDEMIC AND EXPLOITED REEF FISH (Abstract ID: 28978)

Climate change is causing range shifts of marine species, calling for adaptive management of fisheries resources and conservation of marine biodiversity. The waters off Western Australia (WA) are a model system to study range shifts. They present consistent environmental clines and are also a hotspot for endemism and ocean warming. Recently this region experienced rapid warming during the 2011 marine heat wave. We assessed demographic responses to rapid warming of baldchin groper Choerodon rubescens, a wrasse endemic in WA and a fisheries target, which occurs from tropical to temperate reefs. Range-wide data on abundance, recruitment, size structure, ecology and genetic connectivity are presented. Subsequent to the 2011 heat wave, the abundance distribution of recruits showed a displacement to the south when compared to that of adults. We found high recruitment at the temperate edge and no recruitment at the tropical edge. Recruits were consistently associated with habitats at the margin between reef and sand, indicating availability of this habitat type is likely to limit expansion at the cooler edge. Unique use of genomics traced the origin of this southern recruitment pulse to central populations 400 km upstream that experience different environmental conditions. Juveniles at the southern end are feeding on common prey and have survived over five winters. Whether they grow to maturity and reproduce is yet to be determined but crucial to their poleward range shift. C. rubescens shares a similar distribution to many WA marine endemics and may serve as a model species for managing this vulnerable group in a changing climate.

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LIONFISH FEEDING HABITS AND THE IMPLICATIONS FOR REEF BENTHIC COVER (Abstract ID: 30077)

The lionfish invasion has become an issue of critical concern in the Western Atlantic. There is substantial research demonstrating the negative effects of the invaders on native reef fish. Surprisingly, little is known about the long-term impacts of invasive lionfish on fish assemblages and the cascading effects on reef benthic cover. We monitored lionfish, their prey, and benthic composition on 16 patch reefs over a five-year period in South Eleuthera, The Bahamas. On half of the patches, lionfish were removed quarterly. Reef ecosystems are notoriously complex. Thus, to isolate if the alteration in the fish assemblage and secondary impacts (e.g., change in coral/algae cover) were a result of lionfish predation, lionfish feeding habits were investigated in a lab setting. We identified which prey species lionfish preferred by comparing the gut contents of wild caught lionfish to available prey on the reef. This information was used to design experimental choice trials using species frequently found in lionfish stomachs and species present on the reefs yet avoided by lionfish. We also experimentally examined the role of prey abundance on lionfish feeding choice. Collectively, established monitoring programs and improved understanding of lionfish feeding behaviour are fundamental to understanding and predicting the long-term impacts of lionfish and can be used to inform conservation and mitigation strategies throughout the region.

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PRINCIPLES FOR IMPROVING KNOWLEDGE EXCHANGE AMONG SCIENTISTS AND DECISION-MAKERS TO FACILITATE THE RESILIENCE-BASED MANAGEMENT OF CORAL REEFS (Abstract ID: 29107)

The resilience-based management of coral reef ecosystems requires knowledge exchange between scientists and decision-makers, however, the uptake and integration of science into decision-making processes remains a significant challenge. Rather, evidence suggests that decision-makers rely on individual experience or other secondary sources of knowledge in isolation from scientific evidence when formulating decisions, potentially compromising the effectiveness of their decisions. Using both quantitative and qualitative research approaches, we survey coral reef scientists and decision-makers from around Australia to identify, and develop strategies to overcome, the barriers prohibiting knowledge exchange among the two groups. We find that barriers include cultural differences between scientists and decision-makers, the inaccessibility of science to decision-makers, and institutional barriers that limit the extent to which coral reef scientists and decision-makers can prioritise knowledge exchange activities. We also identify guiding principles that should be implemented as part of any applied coral reef research program including: (i) stakeholder mapping prior to the commencement of research programs to identify all stakeholders, (ii) research questions to be co-developed by all stakeholders, (iii) implementation of participatory research approaches, (iv) use of a knowledge broker, and (v) tailored knowledge management systems. Finally, we articulate the individual, institutional and financial capacities that must be developed to underpin knowledge exchange strategies.

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PUSH-CORE SAMPLING IN MICRONESIA: USING PALEOECOLOGICAL DATA TO RECONSTRUCT GUAM'S CORAL REEF COMMUNITY (Abstract ID: 28387 | Poster ID: 14)

Since the early 1970's, the coral reefs of Guam have been declining with a measurable reduction in live coral cover, a trend documented elsewhere and attributed to a range of anthropogenic stressors. To determine both the nature and extent of decline, we extracted push-cores from back reef coral holes (i.e., coastal karst formations that have since been inundated with water and marine sediment due to rising sea levels) from two sites on the western side of the Guam. The cores ranged from 70 – 125 cm and the oldest was carbon dated back to approximately 500 years. The cores were separated into 5 cm sections processed using 2000, 4000, and 8000 µm sieves to separate out coral fragments. The coral fragments were identified to family to create a long-term record of Guam's near shore reef communities and to provide historical context for evaluating both the rate and magnitude of change. We also discuss key assumption in our novel application of push-coring and its potential for future studies.

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UNDERSTANDING THE BIOGEOCHEMICAL FUNCTION OF THE WORLDS CORAL REEFS (Abstract ID: 30004)

Coral reefs throughout the world are under increasing pressure from anthropogenic perturbations which threaten to shift reefs from a state of net $CaCO_3$ production to net dissolution. Once a reef becomes net dissolving it can no longer maintain the growth of $CaCO_3$ structures critical for sustaining the diversity and abundance of life on coral reefs. Therefore it is critical to monitor and predict how anthropogenic forcings will affect the balance of net ecosystem calcification in reef ecosystems. Currently, most coral reef monitoring projects rely on visual measurements of benthic composition and do not measure seawater chemistry parameters such as total alkalinity (TA) and dissolved inorganic carbon (DIC). Vector analysis of TA and DIC can be used to determine the relative influence of organic (photosynthesis/respiration) versus inorganic ($CaCO_3$production/dissolution) processes occurring on a coral reef. Results from a mesocosm study demonstrate that benthic community composition is reflected in the TA-DIC slope of the overlying seawater. An analysis of 23 coral reef locations around the globe showed that there is a diverse range in TA-DIC slopes (0.24 to 1.36), indicating a large range in the biogeochemical function of reef ecosystems. A simple model demonstrated that reefs with slopes greatly different from 0.95 have a dramatic increase in the diel variability of seawater pH, which is exacerbated by ocean acidification. Monitoring the pulse of coral reefs via TA and DIC measurements through time and space could help to better inform conservation and management efforts.

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LAYER BY LAYER – TRANSCRIPTOMIC AND PROTEOMIC ANALYSIS OF HEAT-STRESSED STRAINS OF AIPTASIA PALLIDA (Abstract ID: 29364)

Corals and their endosymbionts Symbiodinium, are key building blocks of the coral reef ecosystem. However, environmental stress imposed by increasing temperatures lead to the breakdown of symbiosis, known as bleaching. The capacity of corals to maintain their symbionts through acclimatization is crucial for coral reef resilience. Comparative heat-stress studies of coral species capable of inhabiting wide environmental gradients, have shown different gene expression patterns possibly linked to bleaching resistance in individuals from warmer regions. Transcriptomics is used as a proxy for gene activity and associated protein content. However, with growing knowledge of post-transcriptional regulation (e.g. miRNAs), it may be erroneous to make such assumptions. Our preliminary study showed that the increased expression of some genes was not reciprocated at protein level. This study explores heat-stress associated changes in transcriptome and proteome layers of the cnidarian model organism Aiptasia from three distinct geographical locations: Red Sea, Florida and Hawaii. Also, the role of the symbiont in thermal stress response was investigated by comparing the same Florida strain infected with Symbiodinium from different clades. Analysis of both layers allows for a better understanding as to what extent transcript levels are an accurate reflection of protein levels. This combination increases our understanding on which genes and associated proteins play crucial roles in acclimatization and further, elucidate factors driving variations in coral thermal tolerance.

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INVESTIGATING SOCIAL DRIVERS OF FISHING AND MARKET INFLUENCES ON INCREASINGLY EXPLOITED SMALL-SCALE CORAL REEF FISHERIES (Abstract ID: 29061)

Many coastal communities in the Pacific are part of complex social-ecological systems that have relied on coral reefs for centuries. Recent pressures including changing climates and economies are threatening the resilience of these systems. This study seeks to better understand drivers of social-ecological resilience and how they are linked through asking: 1) What are the social drivers of fishing effort? and 2) How do markets influence artisanal fisheries (i.e., fishing pressure, gears, target species, distribution of catch)? Data were gathered in 20 Fijian villages using a mixed methods approach including household and fisher interviews, catch logs, and ecological surveys. Structural equation modeling was used to identify the significant drivers of fishing effort and examine links between drivers. While environmental factors are expected to play a large role in driving indicators of reef resilience, social factors (e.g., livelihood diversity, traditional ecological knowledge, resource sharing), although typically ignored in the fisheries literature, explain ~25% of the variation in household fishing effort. Between 50-75% of household catches are used for subsistence, while the remainder is used for sharing and sale. Top predators and larger fish are targeted for sale, often using spears, while a wide range of species and sizes are used for household consumption. The results of this study stress the need to consider the human dimension in coral reef fisheries management and call attention to potential consequences of limited fisheries yields on social resilience.

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MARINE RESERVES LAG BEHIND WILDERNESS IN THE CONSERVATION OF KEY FUNCTIONAL ROLES (Abstract ID: 29182 | Poster ID: 640)

Although marine reserves represent one of the most effective management responses to human impacts, their capacity to sustain the same diversity of species and functional roles

and the same biomass of reef fishes as wilderness areas remains questionable, particularly in regions with deep and long-lasting human footprints. . Here we show that fish functional diversity and biomass of apex predators are significantly higher on coral reefs located at more than 20 hours travel time from the main market compared to even the oldest (38 years old), largest (17,500 ha) and most restrictive (no-entry) marine reserve in New Caledonia (South-Western Pacific). We demonstrate that wilderness areas support unique ecological values with no equivalency as one gets closer to humans, even in large and well-managed marine reserves. Wilderness areas may therefore serve as benchmarks for management effectiveness and act as the last refuges for the most vulnerable functional roles.

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AUTOMATED CHANGE DETECTION IN CORAL REEF IMAGES CAPTURED BY MULTIPLE CAMERAS OVER TIME (Abstract ID: 29244 | Poster ID: 551)

Towards the goal of automatically quantifying significant changes in shallow and wide coral reef areas, we developed a change detection algorithm which can identify presence or absence of benthic objects in the same quadrat. The quadrats were imaged by different cameras under varied capture perspective, illumination, and water condition. Our change detection algorithm is novel because it uses shape detection and feature extraction to process images of life forms with arbitrary shapes having little or no sharp corners from which image registration can be performed. Previous techniques were not as flexible to variations in capture settings and do not take into account real underwater situations where drastic changes can happen such as those caused by typhoons, massive bleaching, and groundings. The algorithm was developed and tested on a set of coral reef images taken within a span of five years from a quadrat in Lian, Batangas, Philippines. Shape features were extracted from the reference images to isolate objects of interest. Local binary pattern (LBP) texture feature histograms were obtained from random patches within the boundaries of these objects across all images in the set to determine presence or absence of reef benthos. The texture vector angle matrices consistently showed small angles when the object of interest is present in the images over time and relatively large angles when the object is absent. Validation resulted to 81% accuracy for presence and 97% for absence.

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THE LINKS BETWEEN CORAL REEF FISH BODY SIZES, THEIR HOME RANGE SIZES, AND STRUCTURAL COMPLEXITY ON A CORAL REEF OF KOH PHANGAN, LOWER GULF OF THAILAND (Abstract ID: 28707)

Decreases in coral reef structural complexity result in the reduction of available shelter to the functionally important fishes. This may strongly impact and restructure reef associated fish communities and subvert functional integrity. Recent research suggests that reduced structural complexity could result in a higher relative representation of fishes with larger body sizes and larger home range sizes. The present study aims to link body and home range sizes of herbivores and corallivores to structural complexity and benthic cover of a small scale habitat. Observations were conducted from 16/03/2015 to 10/06/2015 in 30x5m belt transects on the reef crest of Mae Haad, a bay (~800m length) of Koh Phangan in the Gulf of Thailand. Each belt transect was assessed for: fishes (species, abundance, size classes; visually assessed), structural complexity (rugosity of vertical reef crest contour; chain-and-tape method), and benthic cover (three-dimensional structural elements; line-point-intercept method). The results confirm suggestions of previous studies. Small scale coral reef habitats of low structural complexity (rugosity ~ 1.4) show significantly higher relative representation of fishes with larger home range and body sizes. Corallivory decreases with declining structural complexity while herbivory increases. Fish-habitat interactions with a specific site weaken as structural complexity reduces. These findings have the potential to develop spatial and species-specific management tools that assist in sustaining the ecosystem integrity of Koh Phangan's reefs.

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PATTERNS, CAUSES, AND CONSEQUENCES OF MARINE LARVAL DISPERSAL (Abstract ID: 27896)

Quantifying the probability of larval exchange among marine populations is key to predicting local population dynamics and optimizing networks of marine protected areas. The pattern of connectivity among populations can be described by the measurement of a dispersal kernel. However, a complete empirical dispersal kernel has been lacking for any marine species. We use genetic parentage analysis to quantify a dispersal kernel for the reef fish*Elacatinus lori*, demonstrating that dispersal declines exponentially with distance. The spatial scale of dispersal is an order of magnitude less than previous estimates—the median dispersal distance is just 1.7 km and no dispersal events exceed 16.4 km despite intensive sampling out to 30 km from source. Neither pelagic larval duration nor direction is associated with the probability of successful dispersal. Given the strong relationship between distance and dispersal, we show that distance-driven logistic models have strong power to predict dispersal probabilities. Moreover, connectivity matrices generated from these models are congruent with empirical estimates of spatial genetic structure, suggesting that the pattern of dispersal we uncovered reflects long-term patterns of gene flow. These results challenge assumptions regarding the spatial scale and presumed predictors of marine population connectivity. We conclude that if marine reserve networks aim to connect whole communities of fishes and conserve biodiversity broadly, then reserves that are close in space will accommodate species that are short-distance dispersers.

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MANIPULATING PROKARYOTIC SYMBIONTS TO ENHANCE CORAL STRESS TOLERANCE (Abstract ID: 27936 | Poster ID: 149)

Coral reefs are suffering massive declines due to anthropogenic and other environmental disturbances. While it is urgent to mitigate the effects of climate change, it is also essential to explore ways of augmenting coral tolerance to stress. Here we investigate whether this is achievable by manipulating prokaryotic symbionts. Corals are colonized by a huge diversity of prokaryotes, which exert various beneficial functions, including nutrient cycling and protection from pathogens, thereby directly influencing the health of their host. Acropora tenuis larvae reared in UV-treated and filtered seawater were exposed either to filtered seawater, or to microbiomes isolated from the mucus of coral species known to be resistant or sensitive to heat stress. To assess the feasibility of microbial community manipulations and stability of acquired microbiomes, prokaryotic communities of coral larvae and recruits were regularly sampled for characterization by 16S rRNA gene sequencing. Samples were also collected to quantify the ratio of 16S rRNA to 16S rRNA gene copy number, often used as an indicator of metabolic activity. In addition, samples were fixed for analysis by fluorescence in situ hybridization in order to localize prokaryote groups within coral tissues. In parallel, survival and growth of coral recruits was monitored to evaluate how microbiomes influence coral fitness. The potential to enhance coral tolerance to stress via the manipulation of prokaryotic symbionts is expected to provide promising approaches for coral reef restoration.

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NPC PROTEINS ARE KEY PLAYERS IN MOLECULAR INTERACTIONS BETWEEN CNIDARIANS AND THEIR DINOFLAGELLATE ENDOSYMBIONTS (Abstract ID: 29721 | Poster ID: 131)

Cnidarians host their photosynthetic dinoflagellate symbionts in gastrodermal cells, in a phagosome-derived vacuole. The establishment and maintenance of the symbiotic interaction is dependent on intimate molecular communications, including recognition and tolerance of symbionts, as well as adaptations for mutual transport and exchange of nutritional resources. However, environmental perturbations, such as an increase in seawater temperature, may disrupt this partnership, leading to the severe worldwide decline of coral reefs. Here, we will especially focus on the sterol-binding proteins Niemann-Pick C (NPC1 and NPC2), which have been identified by transcriptomic analyses in symbiotic sea anemones. While only one NPC2 gene is present in many metazoans, this gene has been duplicated in cnidarians (at least four copies of NPC2 are detected). However, only one gene (NPC2-d) was upregulated in symbiotic relative to aposymbiotic sea anemones. We investigated the subcellular localization of NPC proteins in the symbiotic sea anemones Anemonia viridis and Aiptasia. We demonstrated that NPC1 is a biomarker of the perisymbiotic membrane and highlighted a subfunctionalization of NPC2-d protein. Potential ligands of NPC2 proteins were also investigated using Isothermal Titration Calorimetry. In symbiotic cnidarians, NPC proteins may be involved in sterol trafficking but may also participate in symbiont selection and/or symbiont persistence, for example by recognizing dinoflagellates cell-surface glycans. This may explain why several NPC2 genes have been retained in cnidarian genomes.

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APPLYING BIG DATA TO CONSERVATION: AN INDO-PACIFIC SNAPSHOT OF 2300 CORAL REEFS TO INFORM CLIMATE RISK AND REFUGE (Abstract ID: 29953)

Threatened by climate change and anthropogenic impacts, tropical coral reefs face unprecedented losses in biodiversity and ecosystem services in the coming decades. Adaptation, resilience and survival are possible, but a coordinated strategy to guide investments in conservation and management remains unclear. Here, we take a 'big data' approach and compile the largest snapshot of contemporary reef coral biodiversity in the Indian and Pacific Oceans from over 2300 sites in 51 counties and territories provided collaboratively by 100 coral reef scientists (*the "Indo-Pacific Coral Collaboration"). We evaluate Scleractinian coral taxonomic, functional and phylogenetic diversity from over 30,000 mixed-effects models to show that climate-driven ocean warming and local anthropogenic stressors are the strongest drivers of regional coral biodiversity, and that gradients of threat and biodiversity can inform conservation decisions. Our results provide a data-driven portfolio that balances climate risk and refuge in one of the world's most threatened ecosystems, and calls for continued application of collaborative technology and big data science for coral reef conservation. We also discuss an emerging collaboration of field scientists and technologists to develop a standardized open-source database for global coral reef information.
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DARWIN, PIONEER OF REEF TRANSECTS, REEF ECOLOGY AND ANCIENT REEF MODELLING: SIGNIFICANCE OF HIS COCOS (KEELING) SPECIMENS IN THE NATURAL HISTORY MUSEUM, LONDON (Abstract ID: 29356 | Poster ID: 1)

David Stoddart made stimulating contributions to the history of coral reef studies and Darwin's work in particular, including reproduction of important MS material not previously published. We give interim results of our study of Darwin's NHM reef specimens from 'his' atoll, Cocos (Keeling). For Darwin this was his last chance during the Beagle voyage to test his subsidence theory of coral reefs. He needed to show that reef-builders were restricted to shallow water and grew most vigorously along reef fronts and edges since this explained the saucer-like surface topography of atolls. He made qualitative reef transects across the atoll rim, and with FitzRoy and crew made soundings on the deeper reef front. Darwin put his results on to sketched profiles, pioneering the idea of reef zonation in relation to depth and strength of water movement. We relocated his NHM specimens on these profiles. Darwin also sketched two conceptual reef cross-sections at Cocos (Keeling) to model his ideas on reef accretion on a subsiding foundation. They show the influence of Lyell his mentor in using his then new uniformitarian principles to suggest how his model might apply to ancient reefs. While Darwin's model has proved too simple because glacioeustasy in particular was unknown at that time, many of his other ideas, like subsidence, have lasted. His model is also notable for its time for being based on evidence from fieldwork and specimens. Darwin pioneered studies of reef ecology, reef zonation and a unifying approach to the sedimentology of reef growth, ancient and modern.

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SEDIMENT ON REEFS: WHO IS TO BLAME? (Abstract ID: 28139)

Watershed land-use plays a crucial role in the amount of sediment that ends up on the reefs. Remotely-sensed images make evident the interplay of land-use and atmospheric disturbance resulting to higher sediment discharge. Coarse-grid numerical modelling further demonstrates the role of wind-driven currents in influencing the fate of the sediments with some ending up onshore providing new land for mangrove to colonize, others offshore contributing to iron fertilization and others nearshore where they end up smothering seagrass and corals. We contend however, that this coarse model and the paradigm that it supports paint only part of the sedimentation story. Nearshore anthropogenic activities (such as mangrove conversion, coastal structure design and mariculture intensity) equally, if not more significantly, contribute to the sedimentation stress of coral reefs as demonstrated by RS time-series, finer-scale numerical models and sediment budget calculations.

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IS YOUR SCIENCE GETTING THROUGH? COMMUNICATING SCIENCE-BASED INFORMATION ON ECOSYSTEM BIODIVERSITY AND CLIMATE/DISASTER RESILIENCE (Abstract ID: 28127 | Poster ID: 706)

Now more than ever, each and every one need to have some understanding of science, which demands scientists to reach out to the public and communicate the science they generate to help make informed decisions. To bridge communication gaps between scientists, policy makers, and the public, we developed a wide array of communication materials by first identifying (1) who we need to inform (target audience), (2) what they need to know, and (3) what is the most effective way of conveying the critical information. It was crucial to distinguish effective means of delivering specific messages to specific target audiences. We aimed to convey topics of ecosystem biodiversity interconnectivity, disaster risk reduction and management (DRRM), and climate change adaptation (CCA) to our identified groups (primary to tertiary school teachers and students, decision makers and local stakeholders, and the general public). Specific communication materials were developed for each particular group (interactive website, mobile app and tabletop games, animations, media training for scientists, infographics, primer booklet, postcards, telenovela). We also identified that the convergence of knowledge domains is imperative for effective science communication. For each of the communication material developed, we emphasized the contributory role of coral reefs in biodiversity and in providing ecosystem services such as food source; coastal integrity and protection; and tourism and recreation.

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QUANTIFYING DAMAGE TO CORAL COLONIES BY WATERBORNE DEBRIS DURING HYDRODYNAMIC DISTURBANCES (Abstract ID: 29085)

Physical bombardment by waterborne debris is a common disturbance in shallow coral reef systems. Bombardment is especially ubiquitous during extreme hydrodynamic disturbances, such as tropical storms. During a hydroydnamic disturbance, increases in water velocity elevate drag forces acting on unattached objects—ranging in size from sand to unattached coral colonies—propelling them into nearby coral colonies. Bombardment can cause scouring and damage to coral tissue, intra-colony breakage (e.g., branch pruning), and dislodgment of the entire colony. Little is known about the process of bombardment given that it difficult to observe in situ during hydrodynamic disturbances. Therefore, we quantify the damage to coral colonies during such disturbances using photogrammetric scans of coral colonies and finite element analysis (FEA) software. FEA models were created using 3D meshes derived from the scans for a range of different coral growth forms. Models were attached at the base, and estimates of substrate and coral skeleton strength were downloaded from the Coral Trait Database and applied to the models. Bombardment scenarios consisted of spheres of a given size being randomly shot at the FEA models at a range of velocities and the probability of different damage types recorded. The model was validated using imagery of damaged corals following a Category 3 tropical cyclone at Lizard Island on the Great Barrier Reef. We were able to make accurate predictions about the extent of damage caused to corals through bombardment during an extreme hydrodynamic disturbances.

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ACCLIMATION CAPACITY OF A CORAL-ALGAL SYMBIOTIC PARTNERSHIP TO LONG-TERM WARMING AND ACIDIFICATION (Abstract ID: 28017)

Elucidating the responses of symbiotic partners to environmental stressors is becoming increasingly important as climate change disrupts biotic interactions worldwide. We exposed the Caribbean coral *Siderastrea siderea*and its Clade C symbiont to temperature and $pCO_2$ treatments for 95 days and quantified the transcriptomic responses of each

partner using RNAseq. Both elevated temperature and $pCO_2$ elicited strong but divergent responses of the host's transcriptome. High temperatures disrupted molecular homeostasis and substantially reduced calcification rates. Conversely, elevated $pCO_2$ enhanced host transcription of genes associated with respiration and hydrogen ion transport, with only minimal effects on calcification rates—underscoring the role of proton transport in calcification maintenance under elevated $pCO_2$, while also suggesting costs associated with this acclimation. Contrary to the host, the symbiont's transcriptome exhibited little change in response to elevated $pCO_2$. Instead, population-specific transcriptomic responses were observed across fore-reef and near-shore environments—consistent with observed differences in symbiont photosynthetic efficiency across these two reefs. We conclude that host transcriptomic plasticity promotes acclimation to ocean acidification, but not necessarily warming. Given the host's strong transcriptomic responses to acidification and warming, coupled with the symbiont's lack of response, we hypothesize that hosts actively buffer their symbiont's environment.

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THE CHALLENGES OF MANAGING SUGARCANE CULTIVATION IN THE GREAT BARRIER REEF CATCHMENT AREA (Abstract ID: 28420)

Sugarcane cultivation represents one of the primary land uses in Australia's Word Heritage Listed Great Barrier Reef catchment area. With it's identification as a key contributor of coastal nutrient and pesticide exports to marine environments, the sugarcane industry has been the target of considerable natural resource management investment and regulation by various levels of government for more than two decades. Recent combinations of water quality and land use (on-farm) practice change monitoring and modelling suggest results of this considerable long-term investment have been mixed in terms of demonstrable progress towards desired water quality targets. A number of emergent lessons and information gaps are increasingly emerging as critical challenges in addressing these shortfalls including; the challenge of water quality communication extension strategies at the science-industry interface; the spatial variability and development of pollution 'hotspots' from 'diffuse' agricultural pollution, the often locally specific (and in some cases directly contrasting) nature of appropriate on-farm best-management-practices to reduce pollutant losses from farms; and the need for carefully considered, strategic development of on-farm practices to avoid the potential for unanticipated, perverse outcomes from regulation. These themes underline the complexity of managing diffuse agricultural pollution, the general lack of 'silver bullet' solutions to agricultural pollution in the Great Barrier Reef, and the need for flexible, adaptive management frameworks.

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U.S. CORAL REEF TASK FORCE DRAFT HANDBOOK ON CORAL REEF IMPACTS (Abstract ID: 28216)

A handbook on coral reef impacts: avoidance, minimization, compensatory mitigation, and restoration summarizes the present governmental US compliance practices. The handbook represents practices from the 19 US Coral Reef Task Force members (12 federal and 7 local government jurisdictions). This includes practices for planned and unplanned in-water events such as dredging, filling and ship groundings. For planned events a two tiered approach that manages mapping, characterization, alternatives analysis, and compensatory mitigation is presented. For unplanned events, the Natural Resource Damage Assessment process, emergency response, and restoration are addressed. Both consider replacement of lost ecosystem functions and restoration of public trust resources. The Handbook addresses the spectrum of federal and local statutory and regulatory policies for coral reef impacts and the challenges of applying these to coral reefs. It serves as a compendium of practices, case studies, and references. The target audience for this document is agency natural resource managers, proponents of development projects, and incident responders.

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CORAL REEFS IN THE (INTERNAL) SURF ZONE: EXTREME VARIABILITY IN WATER PROPERTIES ON DONGSHA ATOLL, SOUTH CHINA SEA. (Abstract ID: 28301 | Poster ID: 307)

Internal waves are an important process affecting water properties in the coastal ocean and have been observed to influence physical variability on many shallow reefs exposed to deeper waters. Shoaling internal waves can drive strong flows and transport dense, subthermocline water into shallow depths, changing not only the temperature of the water on the reef, but also pH, oxygen, and nutrient concentrations. In June 2014 we used a Distributed Temperature Sensing (DTS) system to give a continuous cross-shelf view of nonlinear internal wave dynamics on the fore reef of Dongsha Atoll, a coral reef in the northern South China Sea. A DTS system measures temperature continuously along the length of an optical fiber, resolving meter-to-kilometer spatial scales at 1-minute temporal resolution. This unique view of cross-shelf temperature structure made it possible to track internal waves across the shallow fore reef and onto the reef flat and to quantify spatial patterns in temperature variability.

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40 YEARS OF BENTHIC COMMUNITY CHANGE AT THE FORE-REEF SLOPE (10 – 40 M) OF THE CARIBBEAN REEFS IN CURACAO AND BONAIRE: THE RISE OF CYANOBACTERIAL MATS (Abstract ID: 28326)

In the past decades benthic sessile communities of tropical coral reefs have undergone significant changes worldwide. Generally, there was a shift from stony corals to fleshy macroalgae. Long-term studies documenting changes in other benthic reef groups, however, are scarce. We have studied change in dominant benthic groups at 4 reef sites in the Caribbean islands of Curaçao and Bonaire over a time-span of 40 years. Permanent 3 x 3 m quadrats at 10, 20, 30 and 40 m depth have been photographed at intervals since 1973. The temporal and spatial dynamics in cover of dominant benthic groups [corals, macroalgae, sponges, cyanobacteria, algal turf and crustose coralline algae (CCA)] were assessed based on image point-analyses. Our results show a strong decrease in the cover of calcifying groups averaged over all sites and depths from 32.9% [1973] to 9.2% [2013] for coral and for CCA from 6.4% to 0.95%. Initially, coral cover is replaced by turf algae (24.5% to 45.3%) and fleshy macroalgae (0% to 12%). These new dominants are however largely reduced from 2000 to 2013 (10.8% and 2.2%, resp.), signalling the rise of benthic cyanobacterial mats (BCM). BCM become the most dominant component increasing from a mere 0.1% [1973] to 22% [2013]. This is accompanied by a small increase in sponge cover (0.5% to 2.3%). Strikingly, the observed pattern of degradation and phase change was seen down to mesophotic depths of 40 m. These results suggest that reefs dominated by algae may be less stable than previously thought and that the next phase may be the domination by slimy cyanobacterial mats.

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NOVEL SURVEY METHOD FOR BIOFLUORESCENT FISHES FINDS LOW ABUNDANCES OF PYGMY SEAHORSES IN INDONESIA (Abstract ID: 28158 | Poster ID: 501)

Pygmy seahorses (*Hippocampus spp.*) are iconic species which are important to SCUBA diving tourism in Southeast Asia. They have been shown to be one of the main drawcards for tourists visiting dive destinations and make significant contributions to the income of local coastal communities. Seahorses are considered vulnerable and all species are protected under CITES. However, information on the life histories and threats of pygmy seahorses is limited and all IUCN- assessed species are listed as data deficient. Research is hampered by the cryptic nature of pygmy seahorses. Their very small size and excellent camouflage makes it difficult to find them using traditional survey methods. We report a new method using biofluoresence for surveying pygmy seahorses. Three pygmy seahorse species (*H. bargibanti, H. denise, H. pontohi*) were found to fluoresce. Further research showed that this biofluorescence could be used as an efficient survey method for *H. bargibanti*. Using this method, extensive surveys at 63 sites across Indonesia (Bali, Nusa Tenggara, North-Sulawesi, Raja Ampat) revealed very low occupancy rates (13.7%) of host seafans (*Muricella sp.*). Additional surveys revealed that this method is not limited to pygmy seahorses. Another 84 cryptic fish species fluoresced at the survey sites, opening up the possibilities of using fluorescence as a survey tool for a wide variety of understudied cryptic species.
https://crittersresearch.wordpress.com

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HOW FAST AND EFFICIENT SPONGE ENGINES DRIVE AND MODULATE THE FOOD WEB OF SHALLOW AND DEEP-SEA REEF ECOSYSTEMS (Abstract ID: 28696)

Ever since Darwin's early descriptions of reefs, it has been a mystery how one of earth's most productive and diverse ecosystems thrives in oligotrophic seas, as an oasis in a marine desert. The recently discovered sponge loop pathway shows how sponges efficiently retain and transfer energy and nutrients on reefs, recognizing their (so far neglected) role as key ecosystem drivers. Evidence now accumulates on sponge loops in other ecosystems, such as deep-sea coral reefs. As a result, current reef food web models lacking sponge-driven resource cycling are incomplete and need to be redeveloped. However,

mechanisms that determine the capacity of sponge 'engines', how they are fuelled, and drive communities are unknown. I will discuss the establishment of a novel reef food web framework, integrating sponges as key ecosystem drivers. To this end, existing critical knowledge gaps at both organismal and community scale will be identified. Sponges will be evaluated on functional traits (morphology, associated microbes, pumping capacity) in the processing of dissolved food, the main fuel of the sponge engine. To what extent these different functional traits are a driving force in structuring reef ecosystems, from fuel input (primary producers), to engine output (driving and modulating the consumer food web) will be assessed at the community level. The resulting framework will be implemented in a sponge-driven food web model, a much-needed foundation to test and predict future scenarios of changes in shallow tropical and temperate as well as cold-water deep-sea reef communities.

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RECOGNIZING BEST PRACTICES IN MPA AND MPA NETWORK MANAGEMENT IN THE PHILIPPINES: THE PARA EL MAR (MPA AWARDS AND RECOGNITION) (Abstract ID: 29276)

Marine protected areas (MPA) and MPA networks have been proven to achieve conservation and fisheries goals. Improving the management of these MPAs and networks is crucial to better achieve these goals. In 2007, the Philippine MPA Support Network (MSN) developed the biennial Para el MAR ( MPA Awards and Recognition) to provide incentives for good MPA management by giving recognition and awards to the best-managed MPAs and networks in the Philippines. This paper highlights the experiences and learnings of the Para el MAR. One of the best practices of effective MPAs and networks is when governance mechanisms such as legislation, effective management body and management plans are in place. Consistency of key management activities such as enforcement, information education and communication, capacity building, as well as monitoring and sustainability mechanisms such as financing, are crucial in effective management. The Para el MAR has become a sharing and learning venue for these best practices. This has encouraged the MPAs and networks to increase their efforts and improve management. The Para el MAR has enhanced their pride of place and has helped leverage support from private and public partners to improve management in Marine Key Biodiversity Areas (MKBA) where the MPAs and networks are located such as the Verde Island Passage and Lanuza Bay.

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APPLICATION OF NOAA CORAL REEF WATCH'S NEAR-REAL-TIME SATELLITE AND MODEL-BASED DECISION SUPPORT SYSTEM TO LOCAL CORAL REEF MANAGEMENT (Abstract ID: 27989 | Poster ID: 619)

The National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Watch (CRW) program uses satellite, in-situ, and modeled data to deliver online a global decision support system (DSS) that helps managers prepare for and respond to coral reef environmental stress. Near-real-time satellite products are derived from sea surface temperature, light, wind, and ocean color data. Weekly to seasonal forecasts project future reef conditions, informing national and international assessments, management responses, and conservation planning. CRW's DSS is the only global early-warning system for the reef environment. It assists environmental impact monitoring, bleaching risk assessments, and preparation/implementation of timely, effective protective responses and adaptation actions. CRW's alerts of mass bleaching, such as the ongoing global bleaching event, allow managers to communicate quickly with decision makers and the public to reduce local stressors; certain countries have even closed major dive and fishing areas (e.g., 2010). CRW also incorporates climate model predictions to identify regions potentially resilient to climate change, aiding marine protected area planning. This poster discusses applications of CRW's DSS to local coral reef management. CRW directly engages local stakeholders and incorporates user feedback into product development and enhancement. This ensures CRW can provide coral reef managers worldwide with climate-quality, consistent, authoritative information on present and future severity of threats that lead to coral bleaching, disease and other impacts.
http://coralreefwatch.noaa.gov/satellite/index.php

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MANAGEMENT IN SAN FELIPE KEY, A CUBAN NATIONAL PARK, BASED ON ASSESSING CORAL REEF CONDITION AND FISHERIES. (Abstract ID: 28912 | Poster ID: 654)

The San Felipe Keys are located in the Southwest platform of Cuba and were declared National Park in 2010, due to its high ecological value. However, the management plan did not take into account coral reef condition and present fishing activities for more than 60 years. Monitoring of coral health indicators and reef fish associations was conducted with visual census and stereo video between 2013 and 2015. An annual finfish fisheries assessment (2014) was obtained based on catch sample, using length-frequency and gonads maturity analysis. Results showed that bioerosion processes, like bleaching, coral diseases and incrusting organisms, were more active than accretion, especially in zones with higher reef complexity. Fish associations are dominated by small fish and large commercial species are rare (parrot fish, groupers, snappers and other top predators). Also, evidence of snapper's reproductive migration and spawning aggregation sites in areas inside and outside the Park were obtained. Close to 25% of fish catch are unreported and snappers were the most abundant group caught. Overall, 40% of annual catches occurred during reproductive season and 70% of individuals were caught with mature gonads. Yet, a high percentage was captured before reaching the first maturity length, especially Lutjanus analis (80%) and Lutjanus cyanopterus (95%) due to problems in its minimum size. Responding to the confounded local situation, we provide management advice to aid in the conservation of ecosystem biodiversity and to promote sustainable fishing practices to deal with overfishing.

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IMPACT OF LAND USE AND NONPOINT SOURCE POLLUTION ON CORAL REEF ECOSYSTEM HEALTH IN WEST MAUI, HAWAII (Abstract ID: 27860 | Poster ID: 421)

Coral reef health is affected by multiple factors. Although coral reefs are resilient systems, the combination of stressors is proving disastrous. In the past 17 years, West Maui coral cover in near shore reefs declined an average of 37%. Nonpoint source pollution is one of the most prevalent sources of contaminants, which affect aquatic organisms by disrupting ecosystem functions, causing changes in the food chain dynamics and altering species reproduction, growth and behavior. Corals respond to the presence of pollutants by expressing and activating detoxification enzymes. By measuring these enzymes, we can identify the stress level of corals, prior to outright death. The goal of my project is to study which pollutants reach the ocean in West Maui, their availability to marine biota and the corals' molecular responses. I will determine water and sediment contaminant load by Gas Chromatography-Mass Spectrometry (GC-MS), below two sites, during two years. I will be measuring the amount of contaminants in algae, corals, and echinoderms as bio-indicators for coral reef ecosystem health, by GC-MS, to determine bioaccumulation and biomagnification. Expression and activity of detoxification enzymes in coral samples will be assessed by Western Blot and spectrophotometry, respectively. Results from this study will provide information about the quality of the runoff reaching the ocean in West Maui, its bioavailability, and corals' sublethal responses. This knowledge is essential to make adjustments in ecosystem management, to prevent further decline and allow its recovery.

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DIFFERENTIAL EFFECTS OF LIGHT AND FEEDING ON NEW RECRUITS OF PORITES ASTREOIDES FROM TWO REEF SITES WITHIN BERMUDA (Abstract ID: 29522 | Poster ID: 204)

Early life history stages of corals may be more susceptible to environmental changes than adults. Furthermore, inter-site variations in environmental parameters may promote differen-

tial responses to changes. Larvae were collected from *Porites astreoides* colonies from two sites in Bermuda, an offshore rim reef and an inshore patch reef, and the settled recruits were reared for 6 weeks in replicate aquaria under two light levels (mean 200 and 30 μE $m^{-2}$ $s^{-1}$) and were either unfed or fed brine shrimp three times a week. Larval size at collection and new recruit size at 10 days, 4 weeks and 6 weeks were measured by photographic image analysis. Rim reef colonies produced significantly larger larvae and new recruits. When unfed, mean recruit size significantly increased only under the low light treatment, irrespective of reef site of origin. When fed, recruits from the patch reef larvae significantly increased in size under both light levels. In contrast, whereas fed recruits from the rim reef larvae increased in size under low light, there was no size change for fed recruits reared under high light. Feeding increased survivorship, although all recruits held under high light had greater mortality. Feeding also increased zooxanthellae density except for recruits reared from the larger rim reef larvae that remained sensitive to higher light. This study provides insight into factors affecting coral recruitment success and documents the occurrence of functional variability in larvae and recruits of the same species between different reef sites.

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IS PAGODA CORAL TURBINARIA MESENTERINA (LAMARK, 1816), A SUCCEEDER OF RECENT CORAL BLEACHING EVENT IN THE SOUTH EASTERN ARABIAN SEA? (Abstract ID: 29040)

To monitor 2014-15 El Niño driven coral bleaching,we studied species specific variations of bleaching severity and settlement of turf algae on bleached colonies at two near shore shallow (3-7m) reef,i.e. Malvan Sanctuary(MS)and Grande Island (GI)in the Arabian Sea by conducting monthly underwater surveys. The combination of 25sq.m permanent photo quadrat with coral colony tagging and 50m Line Intercept transects were carried out to determine bleaching extent. Both the sites were characterized by low scleractinian diversity (18 and 15 species, respectively), high macroalgae cover(66% and 39%),fewer herbivores(average <50 nos/100 sq.m) and high coastal pressure (fishing and tourism). Massive and encrusting colonies of Porites lutea, P. lichen, P. compressa,Plesiastrea sp.,Favites sp.were susceptible to bleaching, while foliaceous Turbinaria mesenterina colonies mostly unaffected.Bleaching severity was estimated to be 80% and 60% in the MS and GI. In both sites,>90% of the massive Porites were bleached followed by Plesiastrea sp.(79% and 62%),Favites (91% and 45%). By contrast, <3% colonies of T.mesenterina found to be bleached. Insitu observation revealed significantly higher settlement of filamentous turf algae on the bleached colonies(80-95%) subsequent to the bleaching event in both the study sites, further hasten coral mortality. Considering our observations,we point out that ruinous impact of this bleaching event could shift coral community structure from massive and encrusting species to foliaceous species by in an increase in the relative abundance of T.mesenterina.
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INTERACTION BETWEEN COMMUNITY METABOLISM AND REEF WATER PH ON A CORAL ATOLL IN THE SOUTH CHINA SEA (Abstract ID: 28930)

The $CaCO_3$ skeletons of reef calcifiers comprise the building blocks that form coral reef structures. In laboratory and mesocosm experiments, calcification rates of corals and other reef calcifiers decline under elevated $CO_2$ concentrations, raising concerns for the future of coral reef ecosystems under 21st century ocean acidification. However, the chemical environment on coral reefs is strongly modulated by the benthic community and can be quite different from the open ocean. This complicates efforts to project ocean acidification impacts on coral reefs. We investigated the drivers of reef water pH and net community calcification (NCC) on Dongsha Atoll, a remote coral reef ecosystem in the northern South China Sea. In June 2014, diurnal-average NCC was 420 ± 80 mmol CaCO3 $m^{-2}$ $day^{-1}$, greater than any other coral reef studied to date, despite comparable calcifier cover (25%) and open ocean pH (~8.0 – 8.1). Such high NCC rates are likely driven by high daytime on-reef pH (~8.5), which is significantly elevated above that of the adjacent open ocean. Elevated on-reef pH is a consequence of high daytime net community productivity (NCP), most likely caused by high benthic cover of algae (19%) and seagrass (16%). A transient coral bleaching event reduced NCC and daytime NCP by ~50% and in turn decreased average on-reef pH by 0.2 units, in the absence of such changes in open ocean pH. Our findings highlight the interactive relationship between community metabolism (NCC and NCP) and reef water pH that will modulate the sensitivity of coral reefs to future open ocean acidification.

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SUCCESSIVE PHASES OF REEF FLAT DEVELOPMENT THROUGHOUT THE HOLOCENE: INFLUENCE OF HYDRODYNAMIC ENERGY AND SEA-LEVEL CHANGE ON THE GREAT BARRIER REEF (Abstract ID: 28525)

The response of platform reefs to sea-level stabilization over the past 6 ka is well established for the Great Barrier Reef (GBR), typically accreting laterally from windward to leeward. However, this interpretation is based on few cores spread across a range of reef zones and may not fully capture the response of reefs to the Holocene stillstand, including the timing of when they first approached sea-level and the direction, rate and continuity of reef flat accretion. We present a new record of reef flat accretion based on 49 U/Th ages from closely spaced transects at Heron and One Tree reefs, combined with all available published C14 ages from reef flats across the GBR. A distinct hiatus occurred in growth from 3.6 ka to 1.6 ka in the northern, south-central and southern GBR. However, no such hiatus occurs in the central GBR, with ages from 7.6 to 0.9 ka. We conclude that a relative fall in sea-level (~0.5 m), 4-3.5 ka is the most likely explanation for why reef flats in the north and south turned off during this period. Greater hydro-isostatic adjustment of the central GBR and subsidence of the Halifax basin may have provided greater vertical accommodation for the mid-outer platform reefs of the central GBR, allowing them to continue to accrete vertically, despite a relative sea level fall. Further, our results demonstrate that hydrodynamic energy is the main driver of accretional direction, with exposed reefs accreting primarily lagoonward, while protected reefs accrete seawards, contrary to the traditional GBR growth model of windward to leeward directed accretion.

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CARIBBEAN SPONGE PATHOLOGY – THE DIAGNOSIS IS NOT ALWAYS SIMPLE (Abstract ID: 28815)

Despite increasing reports, little is known about the pathologies of coral reef sponges. When sponges die, they leave little evidence of their presence behind; therefore, studying sponge pathologies requires temporal monitoring. For example, long-term monitoring of the Caribbean giant barrel sponge *Xestospongia muta* led to the characterization of sponge orange band (SOB), which often kills the sponge and leaves nothing behind. Despite a decade of research, no specific pathogen or environmental stressor has been identified as the cause of SOB. To date, only two studies have succeeded in confirming Koch's postulates for a sponge disease. Given the diversity of sponges and their variable responses to biotic and abiotic factors, a broader approach is required that considers disease-causing microorganisms, environmental stressors, or a combination of these two. Here we report a new pathogenic condition, Agelas Wasting Syndrome (AWS) of the brown tube sponge, *Agelas tubulata (cf. conifera)*. The tissue loss from AWS was previously interpreted as predatory bite-marks on sponges until individual sponges were monitored over time. This example is the converse of that recently described for the yellow tube sponge *Aplysina fistularis*, which displays pathogenic tissue damage that was found to be the result of predation by cowries that live at the base of the sponge tubes and feed nocturnally. Sponge pathologies need to be studied carefully and on a species-by-species basis, with particular attention paid to sponge ecology and temporal monitoring.

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AN OASIS IN THE DESERT: SOURCING CORALS FROM HARBORS FOR REEF RESTORATION (Abstract ID: 28212 | Poster ID: 306)

The continuous decline of coral reef throughout the world due to anthropogenic activities has encouraged the development of different mitigation strategies, many of which

involve the creation of artificial reefs or the transplantation of corals onto impacted reefs. Both of these strategies involve the need for source corals for the mitigation, as the natural recruitment and growth of coral larvae into adult colonies displaces lost ecological services for too great a period. In Hawaii, where corals grow only a few centimeters a year, this issue is pronounced. Hawaii's Division of Aquatic Resources (DAR) has introduced an innovative strategy to source coral material from boat harbors by removing coral colonies from man-made structures within the harbors, thereby minimizing the impact to wild colonies while selecting coral colonies that have already shown to be resistant to higher SSTs, sewage discharges, pollutants, sedimentation and survival under these dynamic conditions. Such corals may be one answer to improve rehabilitation success on deteriorated reefs. Harvested corals are fragmented down into small fragments and grown out with an exceptional fast growth rate under high maintenance conditions; once they reach an optimal larger size they are re-aggregated into adult colonies which are then transplanted onto natural degraded coral reefs.

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MASS CORAL LARVAL RESEEDING IS A VIABLE OPTION FOR ENHANCING RECRUITMENT AND RESTORING DEGRADED REEFS (Abstract ID: 28445)

Restoring degraded ecosystems is essential for mitigating the effects of anthropogenic impacts and for maintaining biological diversity to ensure the continuous flow of ecosystem goods and services. For coral reefs, innovative restoration technologies aimed at larger scale interventions are considered to be one of the primary potential solutions to the rapid and increasing global problem of reef degradation. This study used low-cost mass larval settlement enclosures to significantly increase coral recruitment on degraded coral reef areas in northwestern Philippines. *Acropora tenuis*larvae were cultured *ex-situ* after colonies spawned, and approximately 400,000 competent larvae were transported and retained in each of four replicate 6 x 4 m reef 'reseeded' plots. Four adjacent 6 x 4 m plots were used as non-seeded control plots for comparison. Immediately after the settlement period, recruitment on tiles in the reseeded plots was very significantly higher (mean 27 ± 13 spat per tile) than in control plots, in which no single recruit was record. There was no recorded mortality of seeded *A. tenuis* juvenile corals on the natural reef substrata or on tiles during subsequent monitoring up to 24 mo. After 2 years, a mean of 24 ± 12.4 *A. tenuis* coral colonies, with ecological volume of 938 ± 288 $cm^{-3}$, survived on the reef substrata within reseeded plots and no *A. tenuis* corals in control plots. The results show that mass coral larval 'reseeding' is an effective method for quickly enhancing larval settlement and stimulating recruitment on degraded but recoverable reef areas, and can rapidly initiate new coral populations.

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SUSTAINING STAKEHOLDER PARTICIPATION IN MARINE PROTECTED AREA NETWORKS IN LANUZA BAY, SOUTHEASTERN PHILIPPINES (Abstract ID: 28567)

Developing innovative ways to increase stakeholder participation and sustainable financing of marine protected area (MPA) management are the focal areas of work in Lanuza Bay. It is in Southeastern Philippines, facing the Pacific Ocean and managed by the Lanuza Bay Development Alliance (LBDA). The primary threat to Lanuza Bay arises from illegal, unregulated and unsustainable fishing. Runoff and pollution from land-based activities such as mining, logging, and wood processing and forest conversion are also a growing threats. At least two reef-associated fish species are depleted and near local extinction. In response, an ecological network of 16 MPAs was established with sizes ranging from 21 to 75 hectares. Each MPA has a fisher organization managing it with support including accident and health insurance, and monthly stipend from the local government, and the LBDA, and Nagkahiusang Mananagat na Nag-amping sa Kadagatan sa Lanuza Bay (NAMANAKA), a baywide social network of fisher organizations. NAMANAKA was established to address issues facing each MPA, capacity-building, organizational development, and sustainable financing. Using the Management Effectiveness Tracking Tool (METT), scores range between 12 to 29, and an overall score of 18 out of 45. Among the identified needs include women participation in decision-making in the overall baywide management, strengthening the LBDA and NAMANAKA, developing new financing mechanisms for MPA management, and increasing awareness of legislators and the general public on biodiversity and MPA information.

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UNIQUE STRUCTURE OF REEF FISH COMMUNITIES IN EAST AFRICA- A STUDY ACROSS 24 DEGREES OF LATITUDE (Abstract ID: 29041)

The coral reefs of East Africa are some of the last to receive in depth surveys and assessments of the structure of their reef fish communities. To date there have been no broad scale studies conducted within a single time period. From Kenya to Mozambique across 24 degrees of latitude, 2,496, 25 m transects at 208 sites structured hierarchically with four sites nested in four locations within 13 regions were performed. This structure allowed us to assess latitudinal patterns, and the spatial scales that are significant in structuring reef fish communities. Data revealed that typical patterns of decreasing diversity, species turn over, and gradual shift in assemblages structure were not as defined as they are on other coastlines. Diversity peaked at ~11°S, and decreased towards 15°S, where it increased again at the most southern region ~26°S. Assemblage structure did not consistently change with latitude and only two main groupings were revealed, a northern group and southern group splitting at ~15°S. There was very little species turnover with over 60% of the species shared across all regions, and between the most northern and southern region over 68% of species were shared. Reefs were highly heterogeneous at spatial scales <10 km. Spatial variability at this scale overrides the processes operating at larger spatial scales leading to the high level of homogeneity scene across the entire coastline. These results have implications for trans-boundary conservation and management efforts, and the definition of biogeographic boundaries. http://www.movingsushi.com

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AN INTEGRATIVE INVESTIGATION INTO THE IMPACTS OF ANTHROPOGENIC STRESSORS ON DEEP-SEA CORALS (Abstract ID: 28388)

As critical inhabitants of deep-sea ecosystems, corals produce complex, heterogeneous habitat and positively influence biodiversity. Further study of these long-lived, slow growing animals is urgently required for conservation purposes, as they are becoming increasingly affected by anthropogenic disturbances like the Deepwater Horizon (DWH) oil spill disaster in the Gulf of Mexico. An unprecedented amount of oil and chemical dispersants were released into the deep-sea during the spill and subsequent cleanup efforts. Detrimental effects have since been documented including impacts to deep-water corals. Live exposure experiments were conducted to investigate the toxicity of oil and dispersants on two coral species, *Callogorgia delta* and*Paramuricea type B3*. The treatments containing dispersants had a more pronounced effect than oil treatments alone. In addition, transcriptomic investigations using DWH spill-impacted corals revealed exposure-induced variations in gene expression including the over-expression of genes coding for Cytochrome p450 (CYP1A1), Tumor necrosis factor receptor-associated factors (TRAFs) and additional genes involved in toxin processing, innate immunity and wound repair. These genes among others found in our expression data serve as useful biomarker candidates for assessing and monitoring future anthropogenic impacts. Our results also provide insights into the stress responses of deep-sea corals, implications of applying dispersants to oil spills and a novel reference assembly for a relatively understudied group of cold-water corals.

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CONTRASTING HABITAT UTILIZATION OF TARGETED REEF FISH SPAWNERS AND JUVENILES: SUPPORT FOR ARCHIPELAGO SCALE MANAGEMENT OF THE MAIN HAWAIIAN ISLANDS (Abstract ID: 28480)

Spawning capacity and survival of juveniles are critical determinants of fish population fitness and depend on habitat characteristics, such as refuge availability. Spatially explicit models, which can predict spawner and juvenile abundance while identifying habitats important for spawning and recruitment success, can provide important information for marine spatial planning. This study coupled fish surveys and remotely sensed maps of habitat complexity and composition, wave exposure and human influence at multiple

scales, with geographical information systems and machine learning methods to predict and map targeted reef fish spawner and juvenile abundance, with a focus on surgeonfishes and parrotfishes, for the Main Hawaiian Islands (MHI). This process revealed that: (1) predictive performance varied by life stage and family across islands; (2) areas with very abundant spawners and juveniles rarely overlapped; (3) key environmental factors included distance to human population, wave exposure, and longitude, with spawners influenced by habitat complexity at multiple scales and juveniles driven by latitude, mesoscale habitat complexity and habitat composition (coral cover); and (4) predicted abundance of surgeonfish and parrotfish spawners were highest on the islands of Maui and Molokai respectively, while surgeonfish juveniles were concentrated on Hawai'i Island, with juvenile parrotfishes being most abundant on Oahu. This study provides high-resolution, spatially-explicit information regarding fisheries production and supports managing the MHI at the archipelago scale.

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COMPARATIVE REPRODUCTION AND GROWTH OF THE PARROTFISHES OF HAWAII: INPUT FOR MANAGEMENT REGULATIONS AND STOCK ASSESSMENT (Abstract ID: 27810)

Parrotfishes (Labridae, Scarinae) rank among the most economically important reef fishes in Hawaii and throughout the tropical Pacific. Many of these protogynous (female-first, sex-changing) fishes are also major habitat engineers of great ecological significance. Yet few data exist on their reproductive dynamics or vital rates in Hawaii or elsewhere. A single minimum body length (12 inches fork length) for the take of parrotfish ("uhu") is presently in effect in the State of Hawaii even though the multiple species contributing to the fishery differ in their fundamental life histories. For this reason we estimated body sizes at female sexual maturity and at sex change from female to male, plus growth rates and longevities, using specimens collected during 2005-2007 and 2012-2014 on Oahu, for the five major (of seven total) species of parrotfishes in the local fishery. Median sizes at maturity (from immature to adult female) differed greatly among the five major species, and sizes at sex change (from adult female to secondary male) were proportional to lengths at female maturity and estimated maximum lengths of the respective species. Growth rates and longevities likewise differed greatly among species but with less proportionality among species than did length-at-maturity and length-at-sex change. Changes in minimum size regulations, in concert with a slot-size limit that protects the largest individuals of both sexes, are suggested for the two largest, fishery-dominant species.

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THE CONTRIBUTION OF DIFFERENT PHOTOTROPHIC ORGANISMS TO THE PRIMARY PRODUCTIVITY OF A CARIBBEAN CORAL REEF COMMUNITY (Abstract ID: 27782 | Poster ID: 279)

While many coral reef communities worldwide have shifted from coral to algal dominance, not much is known on whether these changes in community composition have affected the primary productivity of altered reef communities. Using 13C labeling, we quantified the primary production (PP) rates for several dominant benthic and planktonic autotrophs at 5 and 20 m depth on a typical modern Caribbean coral reef. Primary productivity per unit biomass (in mg C [g dry weight]-1 h-1) was lowest for corals (0.03-0.05), followed by macroalgae (0.41-1.89) and turf algae (0.82-1.68), and highest for benthic cyanobacteria (4.48-6.02). By combining taxon-specific PP rates with estimates of their area-specific biomass, we found that turf algae contributed most (>65%) to the total primary productivity of reef communities at 5 m depth. At 20 m depth, macroalgae and phytoplankton each contributed ~40% to the productivity of the entire reef community while the contribution of corals, turf algae and benthic cyanobacteria was <10%. Comparison of our findings to those of a similar study conducted at the same location 40 years ago shows that turf algae and macroalgae have replaced corals and crustose coralline algae as main contributors to the total productivity of Caribbean reef communities.

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SELF-REPORTED BEHAVIOR, INTENTIONS AND CONTROL MEASURES OF SNORKELERS IN THE MOMBASA MARINE PARK-DO SNORKELERS DO WHAT THEY INTEND TO DO, AND SAY THEY DO? (Abstract ID: 29166 | Poster ID: 628)

Recreational marine resource use is conducted by a varied group of visitors. Regardless of how minimal this resource use is, or what intentions these visitors have, impacts on these resources are unavoidable. Management authorities of these resources need to know the extent of these impacts to further steer management towards protection of these resources. Traditional monitoring of visitors in the past has relied on self-reported behavior by visitors themselves. Self-reporting is not always accurate and cannot be relied upon. This study gathered data on snorkeler's intentions, attitudes, and perceived control to not damaging the coral reef when snorkelling. Furthermore, snorkelers were monitored to obtain actual snorkel behavior These snorkelers were then asked if they contacted the reef during their snorkel activity (the self-report measure for comparison). This research paper shows that even though snorkelers in the Mombasa Marine Park had intentions not to disturb the reef when they snorkel, and also indicated having positive attitudes about not disturbing the reef when they snorkel, they still created impacts on the reef. Furthermore, their self-reported behavior did not correspond with their actual monitored behavior. Monitoring snorkeler behavior is time-consuming and is therefore paired with financial investment, however, if this method is the most accurate method of gathering impact data to be used for management purposes, no other data collecting method should be considered, definitely not one that has been shown to be inaccurate (such as self-reported behavior).

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FUNCTIONAL DIVERSITY OF THE REEF FISH FAUNA ALONG THE LATITUDINAL GRADIENT OF TAIWAN (Abstract ID: 28296 | Poster ID: 508)

The functional diversity (FD), i.e. the diversity of role in the biological communities, is a major determinant of the ecosystem resilience. For the global reef fish fauna, FD has been shown to be sensitive to species loss and a particularly good indicator of environmental disturbances. In Taiwan, reef fish fauna decreases from South to North correlated to the distribution of Sea Surface Temperature. We analyze how this latitudinal gradient affects the functional redundancy and vulnerability of reef fish communities around Taiwan. Ecological niches of 1,447 reef fish species were described using a combination of 6 functional traits known for influencing ecosystem processes. Most of traits values were obtained from database and others were allocated based on authors' knowledge of the species. The number of functional entities (FEs), the functional redundancy (FR), and functional vulnerability (FV) were derived from species richness in 3 regions spanned between 21.9°N and 25.3°N. Our first results show that the number of FEs decreases with increasing latitudes. It was accompanied by a decrease of FV and an erosion of FR. Together, it suggests that the functions provide by high latitude reef fish communities are less sensitive and could demonstrate higher resilience abilities than tropical ones. However, abrupt decrease of species recorded at some high-latitude sites along the last decade suggests that environmental modifications around Taiwan could even imperil the fewer highly redundant functional entities in those locations.

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TYPHOONS AND THE MANAGED REEFS: IMPACTS AND RECOVERY PATTERNS OF REEF BENTHOS AND THEIR ASSOCIATED FISH ASSEMBLAGES (Abstract ID: 29295 | Poster ID: 417)

Super typhoon Bopha (Pablo) hit and devastated large areas in Southern Philippines in December 2012 profoundly affecting their associated reef areas. This study examined the impacts and recovery patterns of reef benthos and their associated fish assemblages in two Marine Protected Areas (MPAs) in Surigao del Sur. The benthic cover and their associated reef fishes were monitored 2 years before and 4 years after typhoon. Coral covers of both MPAs were affected after typhoon resulting to decline coral cover while dead coral with algae and rubble increased. Hard corals such as branching and foliose lifeforms were severely affected. Uba MPA had lower coral cover than Ayoke MPA potentially due to its exposure to wave action. Uba is more exposed while Ayoke is relatively sheltered. In addition, the abrupt decline in coral cover at Ayoke was exacerbated by Crown-of-Thorns outbreak. Fish species richness, abundance and biomass at both MPAs were not affected by the typhoon. In fact abundance and biomass increased despite of these disturbances. After 4 years, coral cover continued to decline with no

signs of coral recovery. Fish abundance and biomass continued to increase until the recent surveys. Increase can be attributed to the protection of the reefs where target or commercially important species contributed much of the increase. Herbivore biomass was also found to be increasing. Hence, protection is essential to increase resiliency from typhoons and other climate change-related disturbances, which are expected to be more frequent and severe in the future.

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A VICIOUS CORAL REEF PREDATOR: MORPHOLOGICAL SPECIALIZATION BROADENS THE DIET OF A MANTIS SHRIMP (Abstract ID: 29795)

Mantis shrimp are ubiquitous predators in tropical coral reefs. "Smasher" mantis shrimp have specialized predatory appendages that produce among the fastest, most powerful strikes ever reported in the animal kingdom. These forceful strikes are particularly effective at breaking hard-shelled prey, such as snails and hermit crabs, and have a large impact on the abundances of these prey. However, some anecdotal observations suggest that smashers also consume soft-bodied, evasive prey. We examined the diet of a Caribbean coral reef flat smasher, *Neogonodactylus bredini*. We coupled studies of prey abundance in the field and feeding behavior experiments to inform a stable isotope analysis of diet using a Bayesian mixing model (MixSIAR). Unexpectedly, we found that soft-bodied prey, primarily fish but also worms and snapping shrimp, comprise a large proportion of the diet, in addition to clams, crabs, hermit crabs, and snails. This result held even when informative priors were constructed to reflect a specialist diet on hard-shelled prey and prey abundances in the field (30-50%, depending on the informative prior). Thus, counter to expectation, the specialized feeding morphology of *N. bredini* corresponds to a broad diet of both hard-shelled and soft-bodied prey. Despite their powerful punch, mantis shrimp are the major diet item of common reef animals. Given that they are very abundant and consumed by a diversity of larger predators, while also consuming many different prey themselves, *N. bredini* are likely an important link in coral reef food webs.
http://scrippsscholars.ucsd.edu/mdevries

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SPECIES-LEVEL VARIABILITY IN SUPEROXIDE PRODUCTION BY SYMBIOTIC CORALS (Abstract ID: 28193 | Poster ID: 107)

Superoxide, a reactive oxygen species (ROS), is both beneficial and detrimental to biological systems. In corals, superoxide has been implicated in bleaching, while also having a potential role in defense against pathogens. However, an understanding of the superoxide dynamics and sources within corals is currently missing due to a lack of direct *in situ* superoxide measurements. By conducting the first direct measurements of superoxide produced by corals on a natural reef during a bleaching event, we show substantial species-specific variation in external superoxide levels, which reflect the balance of production and degradation processes. *Porites lobata*,*Porites compressa*, *Pocillopora damicornis*, and *Fungia scutaria* maintained average external levels of superoxide that were approximately 100, 50, 20, and 2 nM above background seawater concentrations, respectively. However, superoxide levels adjacent to *Montipora capitata* were below levels present in the surrounding seawater, pointing to net degradation of superoxide and possible involvement of extracellular antioxidants. In all species, external superoxide levels were decoupled from the abundance of the photosynthetic endosymbiont *Symbiodinium*. However, aposymbiotic coral larvae and cultures of bacterial symbionts produced extracellular superoxide and may contribute to external superoxide levels. These results suggest potential species-specific roles for extracellular superoxide dynamics in the health, development and recruitment of symbiotic corals.

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RESPONSE OF CORAL ASSOCIATED BACTERIA TOWARD THERMAL STRESS (Abstract ID: 27872 | Poster ID: 150)

The coral holobiont includes the coral animal, its dinoflagellate symbionts, and its associated microbial community. Symbionts complement the host genome by providing metabolic precursors that the coral itself cannot synthesize. In exchange, the host provides its symbionts with material that they can catabolize and feed into their own biosynthetic pathways. The inability to maintain these symbiotic interactions when challenged by an environmental stressor, such as increased sea surface temperature, leads to a decline in coral health that is observed as a rise in the incidence of coral bleaching and coral disease. In this study, we examine the effect of thermal stress on the natural microbial community associated with the outer mucus layer and tissues of the coral, Acropora digitifera. High-throughput sequencing of the 16S rRNA V4 hypervariable region revealed that prolonged exposure to thermal stress causes a shift in the diversity of the coral microbial community. Notably, there is an increase in the population of bacteria often found associated with diseased and stressed corals.These changes may correlate with shifts in the metabolic function of the coral holobiont and may have detrimental effects on the health and resilience of the coral. Taken together, our findings highlight the impact of elevated seawater temperature on the bacterial composition and diversity in corals and the effects of this on host metabolism.
http://msi.upd.edu.ph/~conacoc/

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THERMOTOLERANCE AND PHOTOACCLIMATION IN *SYMBIODINIUM*: PHYSIOLOGICAL AND TRANSCRIPTOMIC APPROACH OVER A TEMPORAL SCALE (Abstract ID: 30028)

We quantified thermotolerance in 11 cultures from different populations of five species of *Symbiodinium* clade A. We grew cultures at 26°C and 32°C over 18 days, measuring growth and photochemical efficiency (Fv/Fm). Thermotolerance was not restricted to a single species but it was widespread across species and cultures, showing a gradient from susceptible to tolerant. All cultures at 32°C decreased growth and Fv/Fm. To test the synergistic effect of temperature and light, we cultured three strains (tolerant, intermediate, and susceptible) in five different light intensities at 26°C and 32°C. Strains surviving stressful light and temperature exhibited less growth and quicker damage by light. To investigate the mechanisms behind thermoacclimation, we cultured *S. microadriaticum* (CassKB8) with intermediate thermotolerance at 26°C and 32°C. Gene expression was explored first using cDNA microarrays before (day -2), and during acclimation (day 6 & 16). Differentially expressed genes (DEG) due to increased temperature were time dependent. DEG on day 16 were likely a result of the start of the stationary phase in culture. Similarly, RNA-Seq data (day 5 and 7) suggest temporal variation in gene expression with major changes in heat-shock proteins and chaperones. Retrotransposons were highly expressed on day 7, indicating high stress during thermal exposure. Adaptation to higher temperatures is not restricted to a single clade or species but it is widespread within species. However, acclimating to higher temperatures compromises health and increases chaperone activity.

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ENGAGING MILLENNIAL NON-SCIENTISTS IN CORAL REEF CONSERVATION THROUGH DIGITAL MEDIA STRATEGIES (Abstract ID: 30088 | Poster ID: 708)

Skandha is a project aimed at raising climate change awareness. Our focus is communicating science to the general public, particularly millennials, as they are digital natives well versed in the language of online media. In collaboration with more than 30 volunteers from different disciplines, Skandha has run several successful campaigns in Mexico City, including raising awareness of energy consumption, and organizing climate change talks with undergraduates. In an online campaign, we repurposed marketing techniques originally developed for commercial needs, and applied them in digital communication of climate science. With these methods, we designed a new digital communication strategy for the Mexican Coral Reef Society (SOMAC), using a Facebook fan page. In the first 3 months we reached more than 1,000 organic likes. In 6 months, 80 posts were published, reaching at least 1,300 people each, resulting in an average of 60 engagement actions per post. For each post in the fan page linked to the SOMAC website, daily visits increased 6-fold, with 86% being new users. The fan page audience is 91% Mexican,

and 78% of the audience belongs to the millennial generation (ages 18-34). Initial results demonstrate that using methods developed for commercial marketing can enhance climate science communication by encouraging social media engagement, leading to increased traffic to environmental organizations' web sites for further learning. Skandha is taking novel steps toward improving climate change awareness and preservation of Mexican coral reefs.

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MACROALGAE AND CO2: EXPERIMENTAL APPROACHES TO UNDERSTANDING CABON-USE STRATEGIES AND COMPETITIVE MECHANISMS BETWEEN ALGAE AND CORALS (Abstract ID: 28677)

Understanding the drivers and mechanisms leading to increased macroalgal (seaweed) abundance in coral reefs is of critical importance. Human-induced ocean acidification (OA) due to elevated carbon dioxide (CO2) concentrations in seawater has been suggested to stimulate macroalgal growth and abundance on reefs. However, little is known about the physiological mechanisms by which reef macroalgae use CO2 or bicarbonate (HCO3-) from the bulk seawater for photosynthesis, or, what species could benefit from increased CO2 under OA. Also, previous experiments have suggested that elevated CO2 benefit macroalgae over corals in competitive interactions, contributing to reef degradation. However, the mechanisms used by algae to outcompete corals under elevated CO2 are unknown. In this talk, I will show how we are using experimental approaches to tackle these questions. For example, the use of carbon isotopes in macroalgae from the Great Barrier Reef (GBR) shows that algae have diverse carbon-use strategies granting them flexibility in the context of OA. Red and brown algae could potentially benefit from increased CO2 and GBR offshore reefs seem more sensitive to impacts of OA induced algal proliferation. Our experiments on how algae outcompete corals under OA show a variety of mechanisms including increased algal allelopathy, elevated algal DOC production and increased coral susceptibility to algal overgrowth. These experimental outcomes are providing key information to fill gaps in our understanding of the impacts of elevated CO2 on the ecology and resilience of coral reefs.

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ARE MARINE SUTURE ZONES EVOLUTIONARY LABORATORIES? INSIGHTS FROM GENETIC STUDIES OF REEF FISH HYBRIDISATION (Abstract ID: 28609)

Closely related species can provide valuable insights into evolutionary processes through their ecology, distribution, and the history recorded in their genomes. In the Indo-Pacific, many reef fishes are divided into sister species in the Indian Ocean and Pacific Ocean, with a zone of overlap in the eastern Indian Ocean; this often leads to hybridisation between them. More recent work has characterised marine suture zones in the Western Indian Ocean and Pacific Ocean. The aim of this presentation is to review genetic studies of reef fish hybridisation in recognised suture zones, and address whether the patterns therein represents incomplete speciation, secondary contact, an evolutionary dead-end (for hybrids) or some combination of the above. Further comparison to studies in the terrestrial realm and the potential application of emerging genomic technologies are discussed.

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THE CONTRIBUTIONS OF SOCIOECONOMIC MONITORING FOR CORAL REEF CONSERVATION IN THE US (Abstract ID: 28085)

NOAA's Coral Reef Conservation Program, in partnership with the National Centers for Coastal Ocean Science, is leading an effort to incorporate social and economic monitoring into a new, integrated national monitoring plan for US coral reef jurisdictions. The National Coral Reef Monitoring Program includes three components: biological, climate, and socioeconomic. The socioeconomic component includes gathering information on population change, use of coral reef resources, and knowledge, attitudes, and perceptions of coral reef resources and management. The overall goal of the socioeconomic monitoring is to track relevant social and economic information for each jurisdiction in order to investigate the impacts of society on coral reefs and the contributions of healthy corals to nearby communities. Data collection is complete for South Florida, Puerto Rico, American Samoa, and Hawaii, while efforts in Guam, the Commonwealth of Northern Mariana Islands, and the US Virgin Islands are in development. The three data streams, biological, climate and socioeconomic, are intended to be combined into a single comprehensive monitoring program for the coral reef ecosystem. As a first step towards integration, the data will be analyzed and scored through the use of indicators in a report card for each jurisdiction. Future steps might include using the data to: understand gaps between actual and perceived resource condition, predict the populations most likely to engage in pro-environmental behaviors, and assess the importance of reef species to the provision of food and livelihoods.

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DERMAL DENTICLES AS A TOOL TO RECONSTRUCT HISTORICAL SHARK COMMUNITIES (Abstract ID: 28658)

What were shark communities like before humans? Ecological surveys and historical records demonstrate significant declines in Caribbean shark populations, yet pre-exploitation baselines are nonexistent. Fossilized dermal denticles – tiny, tooth-like scales lining the skin of elasmobranchs – may offer insight into pre-human shark communities on reefs. Denticles are well-preserved in fossil reef sediments, but their identification represents a major challenge. We built a large reference collection from museum and local collections comprising 215 denticles from 37 species within 16 families. Morphometric analysis revealed that denticle morphology is loosely tied to clade, making species-level identification impossible. We found, however, that denticle traits are strongly correlated with life habit and feeding mode. Fast, predatory sharks possess thin, ridged 'drag reduction' denticles, whereas demersal sharks, such as nurse sharks, are characterized by thick 'abrasion strength' denticles. We extracted 254 denticles from a 7,000-year-old fossil reef and 602 denticles from comparable modern reefs in Bocas del Toro, Panama and classified them using the reference collection. Both denticle assemblages corresponded well with families documented in the region. Preliminary data showed a significant decrease in the relative abundance of 'drag reduction' denticles and an increase in 'abrasion strength' denticles over the past ~7,000 years. This suggests that, irrespective of changes in the number of sharks, an important shift in shark community composition has occurred.

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UNDERSTANDING THE TAXONOMY OF THE MESOPHOTIC CORAL GENUS LEPTOSERIS: THE NEXT CHAPTER (Abstract ID: 28274 | Poster ID: 339)

Growing interest in mesophotic coral reef ecosystems (MCEs) has stimulated interest in the taxonomy and biology of mesophotic corals. A key example is the agariciid genus Leptoseris which is often a dominant coral in MCEs. Historically, Leptoseris has not been well represented in museum collections, and despite the systematic review of Leptoseris by Dinesen (1980), from a taxonomic perspective it has not been widely studied. However, advances in molecular techniques and integrated systematic approaches, combining molecular and micro-morphological studies with traditional macro-morphological approaches, have enabled new insights into Leptoseris. This integrated taxonomic approach has certainly facilitated understanding of mesophotic agariciid corals such as species of Leptoseris and Pavona in Hawai'i (Luck et al. 2013). However, there have been challenges in reconciling traditional morphological characters with the results of molecular genetic analysis for Leptoseris from other geographic areas. Recent research has also highlighted the importance of access to original type material to resolve key taxonomic questions, such as with L. fragilis, the type species of the genus Leptoseris. Here we provide an update on progress in unravelling the taxonomic status of Leptoseris species, in light of the latest research and following the rediscovery of the three syntypes of L. fragilis.

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GENOMIC INSIGHT INTO HOST-ENDOSYMBIONT RELATIONSHIP OF ENDOZOICOMONAS MONTIPORAE CL-33T WITH ITS CORAL HOST (Abstract ID: 29147)

The bacteria Endozoicomonas are commonly detected in healthy corals in coral associated bacteria studies. They are likely to be a core member of coral microbiota, however, little is known about their roles inside corals. To decipher interactions between the bacteria and their coral hosts, we conducted genomic and physiological approaches on the first culturable Endozoicomonas isolated from the coral, E. montiporae. The genome (5.43Mb, 99.8% in completeness) revealed abundant mobile elements than the other Endozoicomonas species. A number of genes potentially related to bacteria-host interactions were identified. Testosterone degrading genes and type III secretion system were commonly present in Endozoicomonas species and that might assist to recognize or deliver effectors to their hosts. Several secreted eukaryotic domain proteins identified, such as myosin-tail domain protein and serine/threonine protein kinases, suggesting this bacterium may modulate its host's signaling pathways and vesicle trafficking. Moreover, the genes of eukaryotic ephrin ligand B2 were surprisingly found in its genome, inferring that the bacterium could enter coral cells by endocytosis via binding to host's Eph receptors. In addition, some T3SS effectors encoded by the bacterium, such as 7,8-dihydro-8-oxoguanine triphosphatase and isocitrate lyase, might prevent mitochondria dysfunction and aid gluconeogenesis efficiency, especially under stress. All those findings suggest that E. montiporae would be a facultative endosymbiont who can recognize, translocate, communicate and modulate its coral host.

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PARTICIPATORY MAPPING: TOOLS FOR INTEGRATING LOCAL KNOWLEDGE INTO MARINE PLANNING (Abstract ID: 28072)

Coastal communities harbor a wealth of social knowledge about their ocean spaces that can lend critical insight to marine planning and MPA design and management. Participatory mapping is an evolving tool that combines traditional stakeholder engagement strategies with GIS techniques to capture and transform place-based knowledge into socio-spatial planning information. When integrated with conventional marine planning strategies, participatory mapping works to translate social perspectives about the ocean and coast into a spatial context while providing a forum for sharing opinions, historical perspectives and perceptions about potential social or ecological impacts of proposed planning strategies. NOAA's Marine Protected Areas Center has designed a participatory mapping strategy to engage marine communities in the documentation of social knowledge to inform a wide range of marine planning efforts. This flexible process has been applied at varying scales and with a wide range of partners and funding scenarios, all with the intent of gathering community perspectives while building relationships and local trust and support for developing marine plans. Participatory mapping promotes collaborative planning, giving communities a voice throughout the decision-making process while yielding valuable, spatial human dimensions information. This presentation will highlight NOAA's participatory mapping efforts, discuss the tools and techniques, and share common challenges and solutions for planning and implementing participatory mapping efforts for marine planning and management.

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RESPONSE OF FISH AND SNAIL CORALLIVORES TO AN OUTBREAK OF ACUTE TISSUE LOSS DISEASE ON THE REEFS OF VAAN ISLAND IN THE GULF OF MANNAR, INDIA (Abstract ID: 28496)

Outbreaks of tissue loss diseases in corals are becoming more common resulting in direct colony mortality and also affecting the animals that depend on corals for food and shelter. We documented an outbreak of an acute tissue loss disease on a reef in the Gulf of Mannar, India and compared the density of fish and snail corallivores in the outbreak area to an adjacent control area. Line-intercept on three transects within each area (outbreak and control) found both areas dominated by the coral, *Montipora digitata*. In the outbreak area, an average of 50% of the *M. digitata* cover was affected by acute tissue loss as compared to 0.33% in the control area. This is the first report of a disease outbreak on the reefs in the Gulf of Mannar. Coral-feeding butterfly fish were observed feeding directly on diseased coral tissue in the affected area but belt transects found the density of butterflyfish to be similar between the outbreak and control area. In contrast, drupellid snails were also observed feeding on disease margins of affected colonies but densities were significantly higher in the outbreak area (avg. 2.2±0.9 snails/m2 coral) as compared to the control area (avg. 0.003±0.001 snails/m2 coral). Drupellids are attracted to damaged coral tissue and our findings suggest that it is likely that snails actively migrated into the affected reef area and were taking advantage of the dying coral tissue. Our observations add further evidence to the potential importance of corallivores on disease processes.

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PREDATOR-PREY INTERACTIONS ON CORAL VS ALGAL DOMINATED REEFS: BEHAVIORAL PLASTICITY AND SURVIVORSHIP OF JUVENILE FISHES (Abstract ID: 27906)

Many healthy reefs dominated by corals have transitioned to degraded reefs dominated by seaweeds. Impact of this phase shift on the behavior and survivorship of coral reef fishes is poorly understood, but could affect survival of recruits and export of juveniles from healthy to degraded locations where fishes could enhance reef resilience and recovery. Using experimental patch reefs in pairs of adjacent healthy (MPAs) and degraded (non-MPAs) reefs, we identified between-habitat differences in predators, patterns of attack, and prey behaviors that affect survival in these divergent habitats. Primary predators in MPAs were rapidly moving wrasses attacking from above; prey here selectively used higher portions of the reefs to visually monitor predators. Conversely, predators in seaweed dominated, non-MPAs were sit-and-wait predators that ambushed upward from the benthos. Prey here selectively used lower portions of reefs where they could presumably better detect chemical cues from sit-and-wait predators. In both situations, prey seemed selected to detect, rather than spatially avoid, predators. Prey fishes reciprocally moved from MPA to non-MPA, or vice versa, experienced a 3-16 fold increase in mortality compared to fishes relocated within their initial habitat. Prey that survived relocation adjusted behaviors to match fishes naturally found within the new habitat. Our findings suggest that habitat quality, predator community composition, and prey behaviors interact to affect prey survival, and that prey behavior is dynamic and crucial as reefs under-go regime shifts

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*TRIPNEUSTES GRATILLA* AS A POTENTIAL DISPERSAL AGENT OF THE CORAL *MONTIPORA DIGITATA* IN BOLINAO, PANGASINAN, PHILIPPINES (Abstract ID: 29894 | Poster ID: 196)

*Montipora digitata* propagates primarily by fragmentation and occurs in isolated yet extensive patches in sandy, shallow reef flats in the northwestern Philippines. The sea urchin *Tripneustes gratilla*, also common in these areas, is known to pick up fragments of rock and algae to conceal itself in the sandy habitat. This study tests if sea urchins can act as dispersal agents of coral fragments by determining whether *T. gratilla* can potentially pick up live corals when presented with live and dead coral fragments, measuring the distance travelled by urchins carrying different sized fragments, monitoring the short-term survivorship of coral fragments after deposition on the unconsolidated substrate, and test tissue histocompatibility among established colonies within the same coral patch. Results suggest that, although *T. gratilla* picked up dead coral fragments more frequently (61%) than live ones (39%) ($X^2$ test, $p<0.05$), it had no particular aversion to picking up live corals. The distances travelled by the sea urchin while carrying coral fragments were not significantly different with respect to fragment size (ANOVA, $p>0.05$). The survival experiment showed that *M. digitata* fragments of different sized survived and continued to grow during the 2-month observation. Fragments from different colonies in the same patches exhibited tissue fusion indicating that growing, established coral colonies tested may have the same colony origin. These results indicate that mobile macrofauna may be crucial in the successful establishment of sessile, clonal organisms such as corals in physically unstable reef areas.

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RECOVERY OF MONTIPORA CAPITATA AND PORITES COMPRESSA FROM BLEACHING UNDER OCEAN ACIDIFICATION CONDITIONS (Abstract ID: 29624)

We experimentally investigated the effects of pCO2 (ambient, 364 micro atm vs. elevated, 750 micro atm) and feeding (fed zooplankton vs. not fed) on the recovery of M. capitata and P. compressa from bleaching over one year to test the following hypotheses: 1) ocean acidification (OA) increases recovery time from bleaching, and

2) zooplankton feeding enhances the rate of recovery from bleaching. Preliminary data shows that chlorophyll a was lower in bleached corals than non-bleached corals initially, but no longer differed after 7 months independent of pCO2 or feeding in both species. However, mortality rates were higher for P. compressa than M. capitata over the course of the experiment. Zooplankton feeding did mitigate the negative effects of OA on P:R in both species despite the overall feeding rates being depressed under OA conditions after 7 months of exposure. The maintenance of biomass across all treatments and species suggests that any negative effects of OA on coral recovery from bleaching might be minimal. Overall, our results to date suggest that zooplankton feeding does play a role in mediating elevated pCO2 during recovery from bleaching, but there is yet no clear pattern of the effects of OA on recovery rates. Additional data, including carbon budgets over the course of the year-long experiment, will be presented. This research will provide new insights in understanding the factors that allow certain corals to recover more quickly from bleaching in an increasingly acidic ocean, providing a tool for identifying coral resilience traits.

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INVESTIGATING POPULATION GENETICS OF THE SCLERACTINIAN CORAL, *MONTASTRAEA CAVERNOSA*, ALONG THE FLORIDA CORAL REEF TRACT'S NORTHERN EXTENT (Abstract ID: 29063 | Poster ID: 317)

Coral reef populations on Florida's central east coast are located at unique boundaries that are susceptible to many anthropogenic influences including controlled freshwater discharge and agricultural runoff. Natural environmental variability is relatively high as a result of seasonal rainfall and upwelling patterns. Neither coral spawning nor gamete development have been observed at the northern end of the Florida Coral Reef Tract, therefore we hypothesize that this region may represent a population sink for many coral species. To better understand coral population connectivity of reefs in Southeast Florida, populations of the scleractinian coral*Montastraea cavernosa* were examined. This species' wide geographic distribution throughout the Tropical Western Atlantic and broad depth range from 3 to 100 meter depths allow comparisons of both horizontal and vertical connectivity. However, few investigations of this species have focused on southeast Florida. Saint Lucie Reef near Stuart and Breakers Reef near Palm Beach represent the upper latitudinal limits for many scleractinian coral species along the Florida Coral Reef Tract. This study aims to compare microsatellite genetic markers from these reefs to understand their connectivity and determine influences of the Florida current on dispersal, recruitment, and population structure.

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INFLUENCE OF ECOSYSTEM COMPONENTS ON QUEEN CONCH POPULATION DENSITIES IN A MARINE PROTECTED AREA IN ST. CROIX, U.S. VIRGIN ISLANDS (Abstract ID: 29788)

The queen conch is one of the most highly valued fishery resources in the Caribbean, but populations throughout its range have declined severely, and available data are insufficient for conducting traditional stock assessments. In most areas, it has been difficult to equally judge the effects of both traditional and spatial management measures. To address this deficiency, we conducted stratified fishery-independent surveys of queen conch in St. Croix, U.S. Virgin Islands, generating habitat-based density data. Regression tree analyses were used to identify relationships between conch densities and measured ecosystem variables. Habitat type was the strongest predictor of juvenile densities, followed by management zone (marine protected area versus open fishing area), and water depth. The model predicted that the highest densities of juveniles would be found in patchy (30-50% cover) and continuous seagrass within the marine protected area in 11-15 m of water (2178 per hectare). Adult densities were predicted to be highest (523 per hectare) across several different habitat types, at depths between 21-30 m also within the marine reserve. This method of extrapolating population densities incorporating multiple ecosystem components represents an innovative approach for assessing the status of this data-limited species. It provides a robust means to evaluate performance of marine spatial protection and can identify key habitat and ecosystem characteristics deserving of additional management consideration.

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OBSERVATIONS ON CONTROLLING CROWN-OF-THORNS STARFISH OUTBREAKS BY INJECTION (Abstract ID: 30106)

In 2012, users of the Great Barrier Reef Marine Park began to report numerous outbreaks of the Crown-of-Thorns Starfish (CoTS) on mid-shelf reefs between Cairns and Lizard Island signalling the start of the fourth major eruption of this native pest since the 1960s. In the same year, the Association of Marine Parks Tourism Operators (AMPTO) mobilised funds from the Australian Government and began a program of diver-based hand control that has since killed over 400,000 starfish by injection. Despite efficiency gains from adopting a more effective inoculant than the one available to past control programs and field reports on starfish relative abundance coming from a dedicated surveillance program of unprecedented resolution, the first year of the AMPTO program was able to cull <10% of the large starfish estimated to exist in the outbreak domain. The control program has since contracted to the local defence of reefs critical to the dive tourism market; a scale at which hand control has proven effective at maintaining coral cover. The failed attempt at population-scale control yields insights into the dynamics of these mass eruptions on the GBR and suggests that a different strategy should be attempted to suppress or delay a fifth cycle of outbreaks.
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DEVELOPMENT OF ACOUSTIC METHODS TO INVESTIGATE HAWAIIAN SEMI-DEMERSAL FISH DISTRIBUTION AND ABUNDANCE FOR MONITORING STOCKS (Abstract ID: 27965)

Presently, only fisheries-dependent methods are used for stock assessment and management of six economically important Hawaiian snapper species and an endemic grouper (collectively known as 'Deep-7'). Active acoustic methods have been successfully employed for stock assessment of semi-demersal fish in non-trawlable regions elsewhere and have potential advantages over the current assessment methods. Acoustic backscatter data and complementary methodologies involving target strength (TS) measurements of tethered fish, video-camera observations, and fishing were used to model TS and develop acoustic descriptors such as aggregation shape, size, and density, individual swimming pattern, distance from bottom, and bottom depth for Deep-7 species. Paired observations of in situ TS and fork length (FL) gave an estimated TS-FL relationship for Deep-7 species: $23.01 \cdot \log_{10}(FL)$-72.18. Acoustic data indicated high spatiotemporal variability, with higher number of detections during daytime than at night. Most Deep-7 fish were found between 110 and 330 m depths, within 50 m of the bottom, with both tightly aggregated and loosely grouped fish contributing significantly to biomass and abundance. While results are preliminary, they indicate that acoustics could be successfully used to monitor Deep-7 stocks in Hawaii. Abundance and biomass estimates can be improved by fine tuning acoustic descriptors using additional data and improving biomass estimates in the deadzone.

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TRANSGENERATIONAL PLASTICITY DEPENDS ON RATE OF WARMING ACROSS GENERATIONS (Abstract ID: 28001)

Predicting the impacts of climate change to biological systems relies on an understanding of the ability for species to acclimate to the projected environmental change through phenotypic plasticity. Determining the effects of higher temperatures on individual performance is made more complex by the potential for environmental conditions experienced in previous and current generations to independently affect phenotypic responses to high temperatures. We used a model coral reef fish to investigate the influence of thermal conditions experienced by adult breeding pairs and their parents on reproductive output and the quality of offspring produced. We found that more gradual warming over two generations resulted in greater plasticity of reproductive attributes, compared to fish that experienced the same increase in one generation. When fish experienced +3.0 °C experienced for two generations reproduction ceased in the expected future summer conditions (31.5 °C). Additionally, we found that transgenerational plasticity to +1.5 °C induced full restoration of previously thermally effect reproductive and offspring attributes, which was not possible with developmental plasticity alone. Our results suggest that transgenerational effects differ depending on the absolute thermal change and during what life stage the thermal change is experienced.

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A NEW, HIGH-RESOLUTION GLOBAL MASS CORAL BLEACHING DATABASE (Abstract ID: 28000)

Episodes of mass coral bleaching have been reported in recent decades and have raised concerns about the future of coral reefs on a warming planet. Despite the efforts to enhance and coordinate coral reef monitoring within and across countries, our knowledge of the geographic extent of mass coral bleaching over the past few decades is incomplete. Existing databases like Reefbase are biased by their voluntary nature and the location of prominent science and/or monitoring programs, thus creating a problem

of false negatives. The spatial extent of reported bleaching events is also unclear, as bleaching is reported as a point event (i.e. lat/long coordinates of the field survey). In this project, we have developed the first-ever gridded, global-scale historical coral bleaching database. First, we conducted a targeted search for bleaching reports not included in Reefbase by surveying the academic and grey literature and by personally contacting scientists and divers conducting monitoring in under-reported locations. This search increased the number of observed bleaching reports by 79%, from 4146 to 7429 (through the year 2012). Second, we employed spatially interpolation, using techniques borrowed from species distribution modelling, to develop annual 4 km x 4 km global maps of the probability that bleaching occurred. The database will help the scientific community more accurately assess the change in the frequency of mass coral bleaching events, validate methods of predicting mass coral bleaching, and test whether coral reefs are adjusting to rising ocean temperatures

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ECOSYSTEM REGIMES AND RESILIENCE OF HAWAIIAN CORAL REEFS (Abstract ID: 29152)

Coral reefs worldwide face an uncertain future with many reefs transitioning from cover dominated by coral to algae. This binary view of coral reefs is limited in that it does not consider the underlying processes and complexities of the ecosystem that might relate to the resilience of coral or macroalgal dominated states. This study utilized a large database synthesized from multiple sources by collaborating with various monitoring programs and stakeholders, allowing analysis at a scale commensurate with ecosystem- and resilience-based management in the Hawaiian Islands. To better describe coral reef ecosystems in terms of the communities that compose them, fish and benthic assemblages were considered together to define reef regimes. Model-based clustering revealed five distinct regimes that were then mapped to understand the spatial distribution and variation across the Hawaiian Islands. With this nuanced perspective of coral reefs, we identified a regime that was classified by low coral and low macroalgae but high fish biomass, and what was previously considered a single coral regime was broken into several regimes that varied in their ecology and relative resilience to human drivers. This project was co-developed with state and federal agencies, NGOs, and community groups to build partnerships for practical implementation of ecosystem-based management by utilizing monitoring data to understand the effects of human drivers on coral reef ecosystems.

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CONTRASTING EFFECTS OF EPIPHYTES ON CALCIFYING VS. NON-CALCIFYING ALGAE IN CLIMATE CHANGE SCENARIOS (Abstract ID: 29159 | Poster ID: 39)

Large benthic foraminifera (LBFs) are vital producers of calcium carbonate, and commonly live as epiphytes on marine algae. Marine algae have large diffusive boundary layers, elevating pH around the algae during daytime photosynthesis. Effects of changing ocean temperature and chemistry on LBFs as epiphytes are unknown. Two macroalgae (a calcifying green algae*Halimeda tuna*, and a non-calcifying red algae *Laurencia intricata*) were incubated with a common epiphytic LBF, *Marginopora vertebralis* in current and future conditions of ocean acidification and warming for 15 days. Increased bleaching of *H. tuna* occured in elevated temperature and acidification when no epiphytes were present, while *M. vertebralis* was resilient to near future conditions. Calcification and growth of *H tuna*decreased in the high temperature and acidification treatment, while those exposed with LBFs were more resilient. Calcification of *M. vertebralis*decreased with increased temperatures, but association with *L. intricata*ameliorated negative effects. Individually, elevated temperature decreased in growth of *L. intricata*, while pH decreased growth of *M. vertebralis*. Incubation together ameliorated these negative effects. Results indicate that in a changing climate, epiphytic LBFs are particularly important to survival of calcifying macroalgae. In contrast, LBFs can benefit from elevated daytime pH conditions in the microenviroment of a non-calcifying macroalgae, ameliorating impacts of climate change.

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PREDICTING CORAL GROWTH (Abstract ID: 29283 | Poster ID: 510)

Predicting reef coral demographic rates is a critical part of forecasting the future of reefs under global change. This is challenging for highly diverse communities such as coral reefs, where a species by species approach is logistically unfeasible. A potential solution is to predict demographic rates from species traits. Here, we test this approach to predict coral growth rates. We ask whether most variation in coral growth rates occurs at the species level, morphological group level or at individual level through time. We estimate growth as change in planar area for 11 species of scleractinian corals, across five morphological groups (tabular, branching, digitate, corymbose and massive), and over five years. We show that coral growth scales with size according to a universal power law (that is the power law exponent is constant across species and morphological groups). Coral growth rates are best predicted from colony size and morphology rather than species. However, annual variation in growth rates is greater than variation among morphological groups, with slow growing morphological groups (massive and digitate) having more stable growth rates than faster growing morphological groups (tabular and branching). Finally, we show that colonial corals have pseudo-determinate growth: on average coral colonies stop growing at a certain size, which varies with morphological group. Colony size and morphological group are the most important predictors of coral growth rates.

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DISTURBANCE MEDIATED ECOLOGICAL TRADE-OFFS DURING CORAL RECRUITMENT (Abstract ID: 28900)

In 1977, Peter Grubb proposed the theory of the regeneration niche: defining the environmental conditions that allow new individuals to colonise an area successfully and become established in the local population. By doing so, ontogenetic trade-offs can be quantified and the recruitment of individuals predicted under multiple scenarios of biophysical forcing. Here, I present the findings of a two-year study in which we combined field observations with laboratory and field experiments to parameterise an individual-based model aimed at developing a mechanistic understanding of the ecological trade-offs that occur during coral recruitment. The investigation focuses on the individual processes involved in recruitment – beginning at larval settlement and continuing until recruitment bottlenecks are surpassed – and incorporates the microhabitat complexity that is key in understanding benthic recruitment. Our results demonstrate that coral settlement is higher in crevices than exposed microhabitats, but post-settlement bottlenecks differ markedly in the presence and absence of predators. Maximum recruitment occurs in crevice microhabitats of uncaged treatments, being 9-fold higher than caged treatments. Overall, we uncover the trade-offs between growth, competition and predation, highlighting how these change and even reverse during ontogeny and under alternate disturbance regimes.

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A HIGH-RESOLUTION CHARACTERIZATION OF SYMBIODINIUM COMMUNITIES ALONG A DEPTH GRADIENT IN THE REEF-BUILDING CORAL SIDERASTREA SIDEREA (Abstract ID: 29615 | Poster ID: 128)

The relationship between corals and their endosymbiotic dinoflagellates, Symbiodinium, is a dynamic yet fragile symbiosis. Understanding the flexibility of this symbiosis is central to predicting the long-term response of corals to climate change. Previous studies have shown corals exhibit different patterns of Symbiodinium community composition between areas of varied susceptibility to environmental fluctuation, such as in shallow versus deeper reefs. Until recently, studies used cloning or electrophoresis-based techniques that are prone to underestimates of diversity. This study applies next-generation sequencing to assess Symbiodinium community composition within the same coral species at different depths. We analyzed the Symbiodinium communities within Siderastrea siderea colonies collected in the Florida Middle Keys reefs at three depths: 11, 18, and 27 m. Symbiodinium community composition was determined using Illumina paired-end sequencing of the cp23S rDNA region. We identified a strikingly diverse Symbiodinium community in S. siderea, comprising multiple types from clades A, B, C, and D. Further, our results demonstrate clear differences in Symbiodinium diversity in S. siderea across depths. S. siderea colonies at shallow and medium depths possessed similar Symbiodinium communities that were in stark contrast to their deeper counterparts. Overall, we provide a considerably more intricate view of the flexibility and specificity of the coral-algal symbiosis across areas with varying degrees of exposure to environmental variability.

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INSIGHTS INTO THE EFFECTS OF TEMPERATURE AND/OR ACIDIFICATION ON CORAL REEF ECOSYSTEMS (Abstract ID: 28119)

Coral Reefs are expected to experience reduced rates of calcification in response to projected ocean warming and acidification. The actual impact of different future scenarios, given as representative carbon pathways (RCP), or the separate impacts of ocean warming and acidification on coral reef calcification need to be quantified if we are to correctly assess the long term costs of different pathways and actions to the maintenance of essential ecosystem services such as coastal protection. In the present study, we determined whole system calcification rates for mini reefs reconstructed from the principal components of a southern Great Barrier Reef fore-reef over annual periods that included natural daily and seasonal variability. The results showed that: (i) under present day scenarios, reefs calcified 3-fold faster in summer than in winter; (ii) reefs failed to calcify over the long-term under RCP4.5 and were in a state of decalcification under RCP8.5, with the principal difference between RCP4.5 and RCP8.5 associated with the level of decalcification occurring at night rather than differences in daytime calcification rates; (iii) RCP8.5 warming decreased reef calcification rate as a result of coral mortality and increased microbial sediment abundance, whereas RCP8.5 acidification decreased reef calcification by increasing decalcification in the dark. The results present empirical support for the consensus that CO2 emissions must be curtailed, but also suggests that the negative impact of acidification on the carbonate balance of reefs predominantly occurs at night.

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A CNIDARIAN-SPECIFIC IONOTROPIC GLUTAMATE RECEPTOR LINEAGE FUNCTIONALLY INVOLVED IN IMMUNITY (Abstract ID: 28405)

Cnidarians perceive their environment and respond through their innate immune system by recognizing ligands and molecular patterns. Transcriptional evidence underlying immune priming by recurrent bacterial challenges within the anemone, *Exaiptasia pallida* identified an ionotropic glutamate receptor (iGluR) as a highly differentiated protein among immune challenged anemones. iGluRs are transmembrane ion channels involved in invertebrate chemosensing and plant iGluR-homologs are implicated in sensing pathogen- and damage-associated molecular patterns (PAMPs, DAMPs) that act together for hosts to differentiate pathogenic-damaging microbes from beneficial or harmless microbes. To infer the evolution and characterize the molecular function of a proposed cnidarian-specific iGluR, phylogenetic analyses were conducted using the full coding gene. Results indicate *E. pallida* iGluR ligand-binding domain is not specific to classical synaptic-involved NMDA, kainate, or AMPA ligands. *In silico* analysis identified potential ligands for *E. pallida* iGluR, then verified by functional response. These findings support the hypothesis that *E. pallida* iGluR belongs to a cnidarian-specific expansion within the phylogeny of iGluRs, and has retained molecular characteristics to respond to chemical stimuli. Based on this, we postulate that iGluRs may mediate PAMP-triggered immunity via calcium channels by pattern-recognition particles. These findings provide the foundation for further functional analysis to understand the role of cnidarian iGluRs.
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PERSONAL CARE PRODUCT POLLUTION ON CORAL REEFS: TOXICOLOGY AND CONTAMINATION OF UV SUNSCREENS, PRESERVATIVES, PLASTIC MICROSPHERES AND OTHER INGREDIENTS (Abstract ID: 29544)

Chemicals from personal care products (e.g., sunscreen lotions, shampoos, soaps) can enter coral reef either through swimmers, or predominantly as sewage effluent. The impact of these chemicals is only now beginning to be discovered. We show the toxic effects to coral, sea urchin embryos, shrimp larvae, and fish larvae exposed to preservatives (e.g., parabens, ethoxyethanol), UV absorbers (e.g., methoxycinnamate, camphor), and different types of microspheres (plastic, castor bean, cellulose). We also show levels of these ingredients in waters of coral reef environments, as well as in corals themselves. We provide a risk assessment as to the threat these ingredients pose to coral reefs. We provide a number of options that local communities, businesses, management agencies, and legislators can implement that will mitigate this source of pollution.
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IN-SITU MEASUREMENTS OF SOLAR EXPOSURE DISTRIBUTION ON A CORAL REEF: PRELIMINARY FINDINGS RELATING TO REEF ASPECT, WATER TURBIDITY AND DOSIMETER DESIGN (Abstract ID: 28454 | Poster ID: 545)

Thin film dosimeters have been used for the measurement of solar radiation since the 1970s. Their application includes personal exposure measurement and environmental exposure monitoring. Polyphenylene oxide (PPO) films have recently been developed for use in various underwater environments. These dosimeters are capable of measuring solar ultraviolet-B (UVB, 290 – 315 nm), which is a recognized physical stressor of corals when combined with elevated water temperatures occurring within the irregular structure of a coral reef. We present preliminary findings employing a newly developed PPO dosimeter clamp deployed upon reef building corals situated within turbid inshore waters of the Great Sandy Marine Park, Southern Queensland, Australia. UVB exposures measured over a 24 hour period during peak summer exposure conditions ranged from 12.11 kJ $m^{-2}$ to 21.13 kJ $m^{-2}$. This preliminary data showed a clear dependence on reef aspect with the highest exposures incident upon north facing (Southern Hemisphere) reef surfaces. We conclude that exposure stress to corals may still occur in shallow turbid water with UVB exposure being strongly associated with reef aspect.

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THE THREAT OF BOAT ANTIFOULANT PAINTS TO CORAL REEFS: PERMENANT MOORING AND ANCHORING SITES AS A SIGNIFICANT SOURCE OF LOCALIZED CORAL REEF DEGRADATION (Abstract ID: 29605 | Poster ID: 465)

Reports have accrued from all over the world for the past 15 years regarding a zone of mortality and degradation regarding permanent moorings for small boats (less than 30 meters), usually the length of the mooring line. We conducted a two phase investigation. The first phase examined the ecotoxicological effects of two major antifoulant ingredients (cuprous oxide, tributyltin) on major coral reef ecological receptors, including sea urchin embryos (Tripneustes gratilla & Tripneustes ventricosus), coral larvae, adult coral, shrimp larvae, and fish larvae (Pseudochromis fridmani, Orchid Dottyback). Cuprous oxide is much more toxic than ionic copper. Nanoparticles of Cu2O (~10 nanometer) were about an order of magnitude more toxic than micro-particles (~30 micrometer). The second phase was an examination of the level of toxicity and contamination of several coral reef sites that contained or had nearby permanent mooring sites. Porewater toxicity and Toxicity Identification Evaluation indicated that over 90% of the toxicity resulted from the two major antifoulant ingredients. Antifoulant paint from small water craft poses a serious threat to coral reefs. Active management of antifoulant paint, small water craft and environmental mooring buoys is necessary to mitigate the damage done to reefs.
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BUILDING MARINE PROTECTED AREA MANAGEMENT CAPACITY AT PRIORITY CORAL REEF SITES IN THE CARIBBEAN REGION (Abstract ID: 29559)

Over the past five years, a successful capacity building partnership has been established between 30 ecologically-connected marine protected areas (MPAs) in the wider Caribbean region, NOAA's Coral Reef Conservation Program and the Gulf and Caribbean

Fisheries Institute. The initiative began with the selection of 10 Caribbean countries to participate in an assessment of MPA management capacity. The assessment applied a new tool for a guided self-evaluation of management capacity by MPA managers covering 25 aspects of MPA management and systematically assessing capacity on a three-tiered scale. Our approach to capacity building has been to facilitate peer to peer learning, strategically targeting the highest priority management needs identified in the capacity assessment. We have formed a learning network of MPA managers and professionals to address needs identified by each MPA through a variety of means, including regional peer to peer workshops, direct technical support, site to site learning exchanges and competitive grants. To date, the partnership has addressed sustainable financing, enforcement, strategic management planning and implementation, outreach and communications, and socio-economic monitoring, while establishing a close-knit network between coral reef MPA managers and organizations with MPA management expertise. Exchanges between the Caribbean and Pacific, and cooperation with other donors and expert partners, have been effective in further building capacity. Site-specific follow-up is helping MPAs increase their management capacity on top priority needs.

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THE INFLUENCE OF CO2 ON CALCIFICATION IN CORAL CELL CULTURES (Abstract ID: 29534)

Understanding the cellular and molecular responses of stony corals to ocean acidification is key to predicting their ability to maintain calcification under high CO2 conditions. Biomineralization toolkit proteins have been proposed for several corals and elucidating the connection between expression of these genes and calcification will allow a better understanding of their roles in the mineralization process. We analyzed cell cultures of the stony coral, Stylophora pistillata, by microscopy, qPCR, western blot, and mass spectrometry to test the effects of increased CO2 on the calcification process at the cellular and molecular levels. S. pistillata cells grown at low (400 ppm) and moderate (700 ppm) CO2 re-aggregate into proto-polyps and precipitate CaCO3. When grown at high and very high CO2, (1000 and 2000 ppm, respectively) S. pistillata cells up-regulate genes for several highly acidic proteins as well as a carbonic anhydrase, but down-regulate longterm cadherin protein production and minimize proto-polyp formation; this coincides with a significant decline in CaCO3 precipitation. Boron isotope measurements on the carbonate phase match previously published values for S. pistillata nubbins rather than inorganically precipitated CaCO3, despite the carbonate's formation in contact with the growth medium rather than in a calicoblastic space. These results suggest that coral cells possess compensatory molecular machinery to deal with ocean acidification. However, the ability of these molecular mechanisms alone to compensate for very high CO2 appears limited.

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RESOLVING MECHANISMS OF LOCALIZED ENVIRONMENTAL RESILIENCE: A CLOSER LOOK AT OCEAN DYNAMICS IN THE VERDE ISLAND PASSAGE DURING THE 1998 BLEACHING EVENT (Abstract ID: 29592)

Known as the "center of the center" for marine biodiversity, the Verde Island Passage (VIP; Philippines) is valued for its abundance of reef fish and coral species. In 1998, anomalously warm sea surface temperatures (SSTs) associated with the El Niño/La Niña resulted in widespread coral bleaching in the Coral Triangle. However, satellite (CORTAD) data indicate that SST anomalies were less extreme in certain regions, including the VIP. In order to diagnose the dynamical mechanisms underlying this observation, we use a high (500m) resolution Regional Ocean Modeling System (ROMS) model of the VIP from 1996-1999, which includes sub-mesoscale features and previously unresolved vertical structure in this relatively narrow passage. Lower SST anomalies in the VIP appear attributable to strong, seasonal surface currents that cool surface conditions through significant island upwelling and mixing resultant from interactions with internal tides. These findings suggest that the VIP's configuration renders it less susceptible to thermal stress incurred by climatic events such as ENSO 1998, highlight the spatial heterogeneity of physical quantities in this geographically complex region, and emphasize the importance of higher-resolution models when anticipating individual ecosystems' vulnerability to climate variability and change.

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GENTOYPING BY SEQUENCING AS A TOOL FOR UNDERSTANDING GENETIC AND GENOTYPIC PATTERNS OF *ACROPORA CERVICORNIS* RESTORATION (Abstract ID: 28176)

Caribbean reef decline has prompted the listing of the coral genus *Acropora* as threatened (ESA) and led to the development of active restoration techniques to facilitate recovery. Expanding efforts demand a better understanding of the genetic drivers of coral growth and survivorship and the implications of active intervention on genetic and genotypic diversity on multiple scales. We describe the use of Genotyping by Sequencing to formulate and resolve genetic questions about *Acropora cervicornis* restoration and conservation in Florida. GBS provides more markers per individual than conventional molecular techniques, enabling a holistic understanding of factors relevant to restoration such as population structure, genotypic diversity within reefs, and genetic diversity of nursery stocks. Using GBS, we resolve novel genetic patterns of *A. cervicornis* in Florida, including high diversity of wild corals and three genetically distinct populations. GBS also highlights large genetic/genotypic diversity within reefs and thickets, suggesting adaptive variation over small distances and providing key information for the development of nursery propagated thicket outplanting. Finally, substantial genetic and genotypic diversity in existing nursery stocks is reflected in variable performance *in situ* and suggests the high diversity of wild and outplanted coral assemblages tempers concerns of reduced fitness due to outplanting. GBS should be incorporated into the restoration 'toolbox' as an important metric for understanding the effects of intervention.

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CLONALITY AND LOCAL DISPERSAL: MAJOR COMPONENTS IN POPULATION MAINTENANCE OF FIRE CORALS IN MOOREA REEFS (Abstract ID: 28586)

Asexual reproduction is commonly thought to decrease evolutionary fitness by reducing genetic diversity in populations. Assessing levels of clonality in reef-building organisms is thus crucial to understand population maintenance and resilience of coral reefs. Although *Millepora* hydrocorals are a ubiquitous component of tropical reefs, information regarding ecological processes driving their population dynamics is still lacking. We investigated whether and how the level of clonality varies in *Millepora platyphylla* populations in five habitats with varying wave energy. We used 12 microsatellite markers to genotype 3651 georeferenced colonies. The great majority of colonies are clones (>72% up to 97%) where wave energy is high (upper slope) and where waves and resultant coral fragments disperse (back, fringing and patch reefs). Clonality is reduced (<60%) on the mid slope where wave energy is lower. Relatively high levels of genetic diversity were estimated in all populations, although 328 clonal lineages (~30% of the 1064 multi-locus genotypes) were identified over the five surveyed habitats. Clones of the same lineage were dispersed among habitats with six clonal lineages that strongly demonstrated morphological plasticity among clones in response to wave energy. Parentage analyses provided the first evidence of larval retention processes in shaping the genetic make-up of *M. platyphylla* populations. This study reveals that clonal propagation combined with phenotypic plasticity and local larvae dispersal is highly successful for population maintenance of fire corals in a marginal reef.

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FORE REEF SPUR AND GROOVE GROWTH AND IMPLICATIONS FOR REEF PLATFORM EVOLUTION (Abstract ID: 28873 | Poster ID: 386)

Coral reefs protect islands and coastlines around the world from the effects of waves and storms. The spur and groove (SaG) zone is a characteristic geomorphic zone occurring on the seaward slope of modern reefs globally. Given the location of SaGs at the seaward fringe of modern reef flats, the direction, rates and mechanisms of SaG formation and growth are critical to understanding reef platform development throughout the Holocene and into the Anthropocene. Our recent research shows the existence of several types of SaGs primarily related to wave energy exposure (both intensity and direction). Here we investigate the formation and evolution of different types of SaGs in the southern Great Barrier Reef (One Tree and Heron Reefs, Australia) and French Polynesia (Moorea). A total of 46 short cores (< 70 cm long) were obtained using a pneumatic drill at ten locations; drilling was undertaken on top of spurs, into spur walls and into groove floors in a planimetric layout across the zone. We present down-core sedimentologic, coralgal assemblage and calibrated 14C AMS age data from SaG features in high, moderate, and low wave energy settings. Preliminary data reveal that high energy spur features in Moorea are typically younger (maximum age 762-945 cal BP) than lower energy spur features in the southern Great Barrier Reef (maximum age 4134-4445 cal BP). Vertical and lateral accretion patterns obtained at these three sites also differ; these patterns are currently under investigation taking into account the dominant energy regime, regional sea-level and reef growth histories.

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EVALUATING PATTERNS OF GENE FLOW IN THE PRECIOUS CORALS*HEMICORALLIUM IMPERIALE/LAAUENSE* ACROSS THE PACIFIC OCEAN (Abstract ID: 28804 | Poster ID: 329)

Soft barriers, as are oceanic currents and large distances between populations, have been considered biogeographical filters rather than physical barriers. Their sporadically permeability shows that dispersal is the main mechanism responsible for biogeographic patterns, but their role in the diversification of marine taxa is not completely understood. Hemicorallium sp. have broad distributions throughout the Pacific Ocean. Recent studies suggest that H. imperiale and H. laauense could comprise a complex given that they are indistinguishable by molecular and morphological methods. Using three populations of H. imperiale/laauense from the North Pacific (NP), South Pacific (SP) and Southern Ocean (SO), we evaluated the potential role of geographic distance and the Antarctic Circumpolar Current (ACC) in structuring gene flow patterns for these deep-sea octocorals. For this purpose, we obtained 75 sequences from three mitochondrial genes and used a combination of population genetics and phylogenetics methods. Shared haplotypes were found between NP and SP, and between SP and SO. Fst values showed no genetic differentiation between SP and SO, however NP had significant genetic differentiation when compared to the other two population; the highest value against the SO. We found low but significant correlation between geographic distance and genetic distance. These preliminary results suggest that the ACC has no effect in the genetic structuring of populations of H. imperiale/laauense. However, the genetic patterns may respond to a scenario of isolation by distance.

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EASTER ISLAND (RAPA NUI) CORALS TRACK 19TH AND 20TH CENTURY DECADAL AND LONGER PERIOD VARIANCE IN SE PACIFIC SEA SURFACE TEMPERATURES (Abstract ID: 29937)

The southeastern subtropical Pacific has been implicated in the modulation of the El Niño-Southern Oscillation (ENSO) over decadal time scales, yet this region is almost entirely devoid of high-resolution paleoclimate archives, making analysis of such climate connections difficult. Here we present 3 new coral stable isotopic records from Easter Island (Rapa Nui) that extend back in time to 1800 CE. Coral growth irregularities are found throughout the three cores, but the use of multiple transects, U/Th dating, and replication across cores has allowed us to develop credible chronologies and replicated isotopic time series. Our primary finding is that Easter Island coral del 18O closely tracks Southern Hemisphere and global instrumental SST during the 20th century. We furthermore suggest that the SST rise associated with global anthropogenic forcing may have been underestimated in this sector of the ocean. We observe multi-decadal variability in the seasonal amplitude of Easter Island coral del 18O throughout the time series. We compare the new Easter Island data sets with previously published coral isotopic records from the Pacific. All records reveal a similar long-term trend towards warming/freshening in modern times, suggestive of a basin-scale increase in the strength of the hydrological cycle. Based on frequency domain analysis and comparisons with other coral records, we see greatest support for the null hypothesis that basin-wide Pacific decadal variability arises from the tropics and is expressed in a symmetrical fashion to the north and south.

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VOICE OF THE SEA: USING TELEVISION TO TEACH CORAL REEF SCIENCE AND PROMOTE STEM CAREERS ACROSS THE PACIFIC (Abstract ID: 29621)

Voice of the Sea is an innovative 30-minute, weekly TV show broadcast throughout the Pacific Region that highlights ocean research and careers in a local context, incorporating traditional knowledge into the STEM cannon and striving to create interest in ocean science research and careers. Voice of the Sea provides a venue for coral reef researchers to share their work with local audiences—those most affected by and with potentially the most to gain from increased understanding of current ocean and climate research in their geographic region. The goal of Voice of the Sea is for viewers to become more science, technology, engineering, and mathematically (STEM) literate in the context of ocean and climate issues. Preliminary research indicates significant increases in viewer interest and understanding of episode content across age groups, with implications for formal and informal communication of science topics. We will share excerpts of Voice of the Sea coral reef research episodes and audience feedback.
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CLIMATE CHANGE STUDIES CAN DIRECT RESTORATION TECHNIQUES TO ENHANCE CORAL REEF RESILIENCE (Abstract ID: 29508 | Poster ID: 470)

By year 2100, the carbonate chemistry of the world's oceans will be profoundly different, yet little is known about how the stress of ocean warming and acidification will influence coral restoration efforts. At Mote we are currently outplanting thousands of *Pseudodiploria clivosa* and*Orbicella faveolata* fragments each year in our efforts to restore Florida's Reef Tract. This study evaluated the physiologic response of *P. clivosa* and *O. faveolata* to address which species and genotypes are most resistant to thermal stress combined with ocean acidification. We measured changes in physiological performance in a full-factorial experimental design with three pHT treatments (control 8.01, mid-century 7.79, and end of century 7.68), distributed between two temperatures (30°C and 27°C) for two genotypes of each species and for two different fragment sizes. After two months, there were no significant differences in net calcification due to temperature or pH conditions; however, there was a significant effect of species ($p > 0.0062$) and genotype ($p > 0.0076$) on net calcification with *O. faveolata* calcifying less than *P. clivosa*. There were also significant differences ($p > 0.0001$) for both species in growth rates due to fragment size, where microfragments grew faster independent of temperature or pH. Data generated from this project greatly improves our ability to predict which coral species and genotypes are likely to persist under chronic environmental change and adjust restoration practices to maximize reef resilience.

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GREEN TURTLE REPRODUCTIVE FAILURE AND MANAGEMENT INTERVENTION AT RAINE ISLAND, GREAT BARRIER REEF (Abstract ID: 30153)

Raine Island is the world's largest green turtle rookery. The future of this population is under threat. Mortality of adult female nesters is up to 2000 individuals in a peak season. Nesting and hatching failure are also occurring on a grand scale. Nesting success is low, around 20%, due to two main causes. Dry sand causes nest collapse and high-density nesting results in frequent inter-turtle nesting disturbance. Re-nesting efforts deplete stored energy reserves and result in fewer clutches laid in a season. Emergence success is low, from 20 – 56%, with embryonic death mostly occurring in early development. Tidal inundation at nest level is widespread and is being investigated as a major cause of hatching failure. With very low hatching success producing a large decomposing biomass there is concern that unsuitable nest environment conditions may also be contributing to hatching failure. Trial re-profiling of the nesting area was carried out in 2014. This produced a more gradual slope and raised height above inundation level within the nesting area. Comparison of trial and control nesting beach areas showed an increase in nesting success (47% vs 26%), more even distribution and reduced disturbance of nesting turtles and increased hatchling production within the trial area. Comparison of nests marked by dGPS and excavated post-hatching however showed no difference between trial and control areas with an average emergence success of 56%. This indicates that hatching failure occurs above inundation level and that inundation is not the sole cause of hatching failure.

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CORAL SKELETAL Δ15N RECORDS PROVIDE A HISTORICAL PERSPECTIVE ON COASTAL CORAL REEFS EUTROPHICATION (Abstract ID: 29131)

Human-driven eutrophication is thought to be a major threat to coastal coral reefs worldwide. Yet, we only have a limited understanding of the causes and the consequences of this problem, preventing the application of adequate mitigation policies. Indeed, we lack crucial environmental baselines to identify the sources of nutrients and understand how these nutrients might have changed the coral reef ecosystem over time. The natural abundance of nitrogen isotopes in coral skeleton-bound organic matter (CS - δ15N) may be a promising tool to identify environmental nitrogen (N) sources and to track their changes over time. Until now, such studies have been prevented by the lack of adequate methodology, mainly due to the low N content in coral skeleton. A recent study provided a sensitive and precise method for analysing CS- δ15N (Wang et al., 2015), paving the way for a new field of investigation. To further explore the ability of the CS - δ15N to track human-driven eutrophication we have generated two annually-resolved CS - δ15N records from cores collected in historically eutrophic places: Guam USA, (56 years) and

Hong Kong SAR (150 years). These two cases revealed that the CS - δ15N recorded significant changes in the N sources on decadal to centennial scales, in response to increasing human activities. The two records showed that sewage-derived N has been present in the environment for more than 50 years. Although these records come from hand-picked locations, they suggest that some coastal reefs worldwide could have been under eutrophication stress for half a century.

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INFLUENCE OF CORAL REEF STRUCTURE ON BEHAVIOR OF CARIBBEAN HERBIVOROUS FISHES (Abstract ID: 29890 | Poster ID: 585)

Grazing activity of herbivorous fishes are essential for resilience of coral reefs. Their specific feeding preferences on turf, crustose and standing fleshy algae complement each other and provide an effective overall control on algal assemblages of coral reefs. However, it's been shown that grazing activity of herbivores can be influenced by resource availability and habitat structure. In this study we evaluated feeding habits and behavior of herbivorous fishes in two distinct Florida reefs, Molasses reef and Conch reef. We characterized fish communities of both sites using 30x2 m lineal transects (n=20) and surveyed benthic community using photo-quadrats (n=200/site). To study fish behavior, we followed target species for 10 minutes (n=156/reef) and recorded interactions and grazing activity of eight parrotfishes. Molasses is a high relief reef with higher density and biomass of herbivorous fish as well as greater abundance of crustose algae and turf-forming species. Conch has lower rugosity with half of the benthos covered by turf algae associated with sediment (TAS) and other 30% dominated by brown upright algae. We found large variability species feeding preferences between both sites. At Conch approximately 50% of fish bites targeted TAS while at Molasses this benthic group was contacted less that 20% of the time. Contrarily, turf, crustose algae and corals were greatly more consumed at Molasses apparently caused of higher resource availability. We found that parrotfish interact more often at Molasses but and spend more time camouflaging at Conch reef. We discussed the implication of these results for coral reef functioning and management strategies.

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FACTORS CONTROLLING SHORELINE CHANGES IN THE NORTHERN TUAMOTU REEF ISLANDS, FRENCH POLYNESIA (Abstract ID: 28598)

This study provides new data on shoreline changes on 111 reef islands of 4 atolls of the Tuamotu archipelago, French Polynesia (Rangiroa, Tikehau, Takaroa and Mataiva), over a 33- to 52-year period characterised by rising sea levels (+2.5 to 2.9 mm y-1). Results show that 75.7% of the islands were in stable condition while 16.8% expanded and 7.5% contracted. Accretion occurred across all island sizes and atoll sides, with the highest rates (>10%) occurring on highly modified islands as a result of land reclamation and of the disruption of sediment transport by causeways and transversal coastal structures. Eighty-two per cent of the islands that have decreased in area are less than 5 ha; most of them are undisturbed by human activities and located on the windward side of atolls. Twelve per cent of the islands have migrated, either lagoonward or oceanward. Three factors contributing to shoreline change are investigated: human factors, sediment supply, and tropical and extra-tropical cyclones. Although they erode islands (with shoreline retreat exceeding 30m in places), cyclones also increase their elevation; after such events, beach resilience occurs over a 10 to 20-year period. The good state and high resilience of coral reefs after destruction, mainly by cyclones, suggests that natural reef islands may continue to be resilient in the next decades. On the contrary, most developed islands have lost their capacity to grow both outwards and upwards. Their situation is therefore concerning in the face of accelerated sea-level rise.

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SPATIAL COMPARISONS OF ZOOPLANKTON ABUNDANCE ON CORAL REEFS IN BOCAS DEL TORO, PANAMA (Abstract ID: 29686 | Poster ID: 358)

Climate change is increasing the decline of coral reef health as rising temperatures result in coral bleaching, often leading to death. Increased heterotrophy has recently been identified as a potential recovery mechanism for certain corals. This study investigates the abundance of zooplankton communities over a large spatial scale (km) across reefs in Bocas del Toro, Panama, to further investigate how heterotrophy may aid in recovery from bleaching. Zooplankton were collected at three depths in both offshore and nearshore reefs, using tows during the day and traps set on the substrate at night to include vertical migration. Nearshore reefs show higher total abundance of zooplankton in comparison to offshore reefs throughout the entire water column. During the day, abundance differs by less than two-fold, whereas at night abundance differs by over an order of magnitude. Additionally, both sites show increased zooplankton abundance in the middle of the water column during the day but more variability and no distinct pattern within the water column at night. These results indicate clear spatial variability, not just patchiness of zooplankton, and suggest further research is needed for plankton dynamics on coral reefs to better understand heterotrophy as a recovery mechanism for bleaching corals. As zooplankton are a critical source of energy to corals, and many other species in coral reef ecosystems, it is important to understand the dynamics of zooplankton on coral reefs to aid in their recovery from potentially negative consequences of a changing climate.

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HERITABILITY AND GENOMIC BASIS FOR VARIATION IN THERMAL TOLERANCE OF THE CORAL HOLOBIONT IN *ORBICELLA FAVEOLATA*(Abstract ID: 29877 | Poster ID: 29)

Sea surface temperatures are predicted to rise 1-2C by the end of the century, and thermally sensitive organisms like reef-building corals will require substantial adaptive responses in order to persist well into the future. Genetic variation that might support adaptive responses has been documented in larval stages of some corals, but the contribution of genetic variation of adult corals and its functional basis remains unclear. In this study, we focus on mechanisms that may enable long-term adaptation by investigating heritable variation in thermal tolerance and its genomic basis in *Orbicella faveolata*, a dominant reef-builder in the Caribbean. Thermal stress experiments were conducted at the Smithsonian Tropical Research Institute in Bocas del Toro, Panama, using coral fragments collected from natural populations. Bleaching responses were quantified and combined with genome-wide SNP genotyping to estimate heritability and test for associations between thermal tolerance and genotypes. Using the linkage map and draft genome assembly for this species, we searched for genomic regions underlying variation within more thermally tolerant phenotypes. We profiled transcriptional responses in the same corals to evaluate whether genomic regions associated with tolerance include genes differentially expressed in heat-tolerant and susceptible genotypes. Integrating genomic and transcriptomic data with quantitative genetic analysis provides a new perspective on the mechanistic basis for thermal tolerance phenotypes and the potential for adaptation to rising ocean temperatures.

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TWO YEARS AND COUNTING: MONITORING AND DOCUMENTING THE ONGOING GLOBAL CORAL BLEACHING EVENT (2014-2016 AND BEYOND) (Abstract ID: 28819)

Regional- to global-scale coral bleaching events have been occurring for more than 30 years. In that time, bleaching has worsened as global ocean temperatures warmed. Unlike the bleaching events in 1983 and 1998, strong El Niüo/Southern Oscillation (ENSO) conditions are no longer needed to cause widespread bleaching but certainly can exacerbate bleaching. The current global bleaching event began in Guam and the Northern Mariana Islands in mid-2014 (following 2013 bleaching there). Thermal stress brought bleaching back to previously impacted reefs and reached areas largely missed by past events (e.g., Hawaii),. Some locations suffered consecutive bleaching in 2014-15 (Hawaii, Florida) or prolonged stress that may last over a year (Kiribati). With the strong 2015-16 ENSO, bleaching may continue through much of 2016 in the Pacific and Indian Oceans and return to the Caribbean. It may even continue into 2017, and will likely spread even more broadly if a strong La Niüa develops. Unfortunately, some key international monitoring efforts (Global Coral Reef Monitoring Network, ReefBase) are no longer fully functional. This places greater pressure on other international (Reef Check, XL Catlin Seaview Survey), regional (e.g., AGRRA), and national efforts to document the bleaching

event. NOAA's Coral Reef Watch is coordinating global data collection and analysis of this event to make sure key scientific information is not lost. This presentation discusses the latest satellite and field data on the ongoing global bleaching event and its impacts on coral reefs worldwide.
http://coralreefwatch.noaa.gov

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SPATIAL AND HOST-GENETIC FORCES STRUCTURE THE MICROBIOME OF THE SPONGE *CLIONA DELITRIX* (Abstract ID: 29669)

Sponges are important members of benthic communities throughout the world. They host diverse symbiont communities with compositions that are largely species-specific and structured by host evolutionary history. However, little is known about how microbiomes vary among spatially distributed populations within a species. In the current study, we investigated how the microbiome of the coral-excavating sponge *C. delitrix*varied in relation to genetic differentiation and habitat location. Sponge samples from four distinct populations in the Caribbean were collected, and 16S rRNA amplicons were Illumina-based sequenced as part of the Earth Microbiome Project (EMP). Our analysis revealed that microbial diversity was consistent among all locations and populations, while both genetic and environmental forces influenced the microbial composition of sponges. Additionally, we found that *C. delitrix* maintains a "core" community across all sites in the Caribbean, with 62 microbial taxa found in at least 85% of all samples. Most of these microbial taxa were unique to *C. delitrix* or were only additionally found in the congener *C. celata* . Interestingly, all of the genera- and species-specific taxa were rare in the host microbiome. Our results indicate that *C. delitrix* microbiomes are a complex consortia of microbial taxa structured by both host-genetic and environmental forces, while maintaining a core group of microbial symbiont taxa reflective of broader host evolution.

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REEF ECOLOGY – REEF ISLAND CONNECTIVITY ON HUVADHU ATOLL RIM, MALDIVES (Abstract ID: 28321)

Coral reef islands are low-lying (typically <3 m above MSL) accumulations of bioclastic sediment produced by the surrounding coral reefs. Given their low elevations and reliance upon locally generated sediment, they are regarded among the most vulnerable environments to sea-level rise. Understanding the linkages between reef ecology and reef islands is thus crucial for assessing future island resilience. Here, we present a holistic study of reef ecology-reef island linkages within a section of Huvadhu Atoll rim. This is the first detailed study of marine-island connectivity to be undertaken in an atoll rim setting in the Maldives. Sediment production rates were quantified using ecological survey data of sediment producers. Connectivity was assessed through comparisons of marine, beach, and island (from a series of cores) sediment samples (n = 157). Estimated annual sediment production was 382,000 kg across an area of 1.3 km2. Sediment production rates ranged from 0.05 kg m-2 yr-1 in the oceanward sand zone to 0.84 kg m-2 yr-1 on the lagoonward reef crest. Excavating parrotfish were identified as the dominant sediment producers, accounting for 79.4% of production. Marine, beach and island sediments were dominated by sand-grade coral (63%, 61%, 74% respectively). As parrotfish are the most likely source of sand-grade coral, this reflects the reliance of rim island systems on a limited range of sediment producers. Hence, ecological shifts associated with environmental change may have a critical impact upon future reef island vulnerability in the face of sea-level rise.

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PALEO-GEOGRAPHIC DIVERSIFICATION AND ENVIRONMENTAL DEPENDENCE OF THE LARGER FORAMINIFER HETEROSTEGINA (Abstract ID: 27868)

The worldwide distributed larger benthic foraminifer (LBF) Heterostegina prefers oligotrophic environments in tropic and warm temperate seas. Harboring diatoms enables the broadest distribution along the illumination gradient within LBF. Down to the fair weather wave base Heterostegina protects entrainment by living in holes of structured boulders. The dependence on light intensities is managed by increasing surface/volume ratios correlated with decreasing light. The dependence on hydrodynamics leads to a shift in proportions between schizonts (smaller proloculi) and gamonts (larger proluculi) along the hydrodynamic gradient. The dominance of schizonts in high energetic environments, the mixture between schizogony and gametogony and the dominance of gamonts in low energetic environments leads to an apparently gradual increase of proloculus size with decreasing hydrodynamics. Additionally, the negatively correlated number of operculinid chambers apparently changes along the hydrodynamic gradient. Both characters were used as the most significant metric characters in the evolution of Heterostegina. Beside the environmental dependence, proloculus size can differ between biogeographically different populations (e.g., Okinawa, Hawaii) taken under similar hydrodynamic conditions. Therefore, paleogeographical differences leading to subspecies together with transport, reworking and time-averaging possibly lead to erroneous interpretations of evolutionary lineages. Using growth-independent and growth-invariant characters describing the internal test morphology completely allows a much better interpretation of evolutionary tendencies separated from paleogeographic diversification.
http://www.univie.ac.at/Palaeontologie/

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DECADAL TRANSITION IN CORAL REEF STATUS, DISTRIBUTION, ISSUES AND CONSERVATION INITIATIVES IN GULF OF MANNAR, SOUTHEASTERN INDIA (Abstract ID: 29196)

The coral reefs of Gulf of Mannar are distributed around 21 islands and show resilience after complete halt of mining in 2005 and other conservation initiatives. Considerable awareness and capacity building, coral rehabilitation, protection and livelihood support has been provided to coastal communities after the major Indian Ocean coral bleaching event in 1998, and live coral cover increased from 37% in 2005 to 43% in 2009. Though there was loss of 10% live coral in 2010 due to prolonged elevated sea surface temperature (32oC) resulting bleaching and mortality, the reefs showed resilience to reach 39% live coral cover in 2015. Coral recruitment density increased significantly from 0.65 to 0.86 no/m2 between 2005 and 2015 and more recruits dominated by genera like Acropora, Montipora, Pocillopora, Porites, and Turbinaria. Recruits are occupying the nearby sandy and seagrass areas, and in Vaan Island, live coral cover area increased from 2.75 to 3.5 km2. The coral communities shifted from dominance, for example from P. damicornis to Acropora and Montipora in Shingle Island. However, issues like invasion of exotic seaweed, diseases, poaching reef associated ornamental fishes and elevated temperature pose challenge to reef managers. Over 1.2 Km2 reef area was affected by exotic seaweed invasion. Tissue loss disease (white syndrome) and growth anomalies along with several types of lesions was noted in 9% of the corals in 2015. The intensity of 2016 coral bleaching is alarming. To address the issues and to maintain reef health, regular monitoring, coral rehabilitation, capacity building, and community involvement programmes are implemented.
http://sdmri.in

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A CHARACTERIZATION OF THE SPATIAL PATTERNS OF SCLERACTINIAN CORALS AT PALMYRA ATOLL (Abstract ID: 29922 | Poster ID: 552)

Coral reefs are spatially complex habitats, yet our understanding of their non-equilibrium dynamics is largely based upon percent cover data using imagery of limited scale (< 1 $m^2$). However, ecological processes leading to differences in the spatial patterns of individual coral colonies cannot be detected from percent cover based analyses. As a result, we lack a robust and highly taxonomically resolved appreciation of landscape-scale patterning in coral reef environments. Here we investigate the spatial patterns of hard coral assemblages at Palmyra Atoll using large scale photomosaic images, each covering 100 $m^2$ of benthic habitat. All individual coral colonies were mapped and identified to the lowest taxonomic level possible, and using spatial-analytical techniques we investigated departures from spatial randomness. While patterns of dispersion were variable, all taxa showed some degree of clustering. Despite this, the distributions of a number of taxa did not significantly depart from randomness. We did not observe over-dispersion in any of the observed taxa. Further for many taxa, the level of clustering was linearly related to abundance, suggesting density dependence in dispersion. These patterns, at least partially,

result from important biological processes such as differences in reproductive strategies. The data provided by photomosaics allows us to not only quantify ecosystem state, but also identify patterns in spatial structure, which can lead to critical inferences about the underlying processing structuring a variety of natural systems including coral reefs.

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IMPLEMENTATION OF LARGE SCALE MONITORING PROGRAMS AS A PLATFORM FOR TERRITORIAL CONSERVATION AND MANAGEMENT (Abstract ID: 28352)

Development and implementation of large spatial scale monitoring programs is a complex process requiring advance planning and strong partnerships. Project goals include, building a scientifically sound monitoring platform that compliments current local monitoring efforts within a territory by providing broader spatial resolution to further assist in the management of local resources. When working remotely, resources and personnel become precious commodities, therefore proper planning and coordinating well before implementation is pertinent for execution. The National Coral Reef Monitoring Program (NCRMP) is one such example; a strategic framework funded by NOAA's Coral Reef Conservation Program (CRCP) for conducting sustained observations of biological, climatic, and socioeconomic indicators in U.S. states and territories. This presentation will focus on the development of the biological monitoring plan for Puerto Rico by providing a road map of capacity building and leveraging of resources within the territory wherever possible. Current effort within Puerto Rico include federal, territorial and NGO partners and coalesces these groups to work collectively on a common objective. Integration of NCRMP data into local research and management plan development within the North East Reserve (NER) will be highlighted to emphasize the synergy of this new monitoring program and augmenting local resource management and conservation.

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REEF FISH AS POTENTIAL LINKS ACROSS HABITATS IN A BRAZILIAN TROPICAL SEASCAPE (Abstract ID: 28754)

Seascape connectivity is regarded as essential for healthy reef fish communities in tropical shallow systems. Seagrass beds and mangroves often constitute important nursery habitats, with high structural complexity, supplying juvenile fish with food and protection from predation. The Brazilian seascape is considerably different from the Caribbean and Indo-Pacific shallow seascapes, particularly regarding seagrass beds, which in Brazil cover small areas and have very low structural complexity. Macroalgal beds may therefore be of more importance as nursery habitat for juvenile coral reef fishes in Brazil. Here, we investigate the extent to which fish communities demonstrate habitat connectivity and identify possible nurseries in a Brazilian seascape within three shallow reef systems. Fish communities were surveyed on the fore reef, back reef, in seagrass beds and Sargassum-dominated algal beds. Seagrass beds contained very low abundances and species richness of fish, while algal beds contained significantly more juveniles than all other habitats, including species that are found on the reef as adults. Fish species associated exclusively with seagrass were not observed. Connectivity and thus pathways of nutrient transfer seem to function differently in Brazil compared to the Caribbean and Indo-Pacific, with Sargassum-dominated beds being important as nurseries for a larger number of species than mangroves and seagrass beds. Results suggest that macroalgal beds are important nursery grounds for many reef fish species, thereby functionally structuring the adult coral-reef fish community.

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WORLDVIEW-2 SATELLITE MAPPING OF THE NEARSHORE ECOSYSTEMS AROUND TIMOR LESTE: GOALS, CHALLENGES AND ACCOMPLISHMENTS (Abstract ID: 29124 | Poster ID: 537)

Timor Leste and the Coral Triangle region in general represent a hotspot of marine biodiversity. Coral reefs in the region provide an important source of food and income for local economies and provide coastal protection from storm and tsunami events. NOAA, along with partners from U.S. Agency for International Development (USAID), the U.S. Department of State, and the multilateral partnership of 6 countries in the Coral Triangle region, have been providing technical assistance to support implementation of an Ecosystem Approach to Fisheries Management (EAFM) in Timor Leste. Despite numerous challenges, this project utilized high resolution World View-2 satellite imagery to provide seamless regional shallow water bathymetry and benthic habitat data and maps for nearshore waters around Timor Leste. Prolonged high turbidity on the southeast and portions of the northeast coasts resulted in poor visibility and limited usability of some of the satellite images. The lack of relevant bathymetric and benthic habitat ground-truthing data has also been problematic. We addressed these issues by continuously adapting data processing methods to the quality of each satellite image. Here we present an overview of our seafloor depth derivation and habitat characterization methodology, which we use to obtain partially complete bathymetric data coverage and complete benthic habitat data coverage for the shallow (0-20 m) coastal seafloor around Timor Leste. These data layers are an integral part of the EAFM under development for Timor Leste.

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CORAL-ALGAL COMPETITION INDICATES A NEGATIVE IMPACT OF LAND RUNOFF FROM RURAL COMMUNITIES ON CORAL REEFS IN FIJI (Abstract ID: 29749)

Coral-algal competition is ubiquitous in coral reefs worldwide and has the potential to provide a useful snapshot of the state of the benthos. The majority of people in Small Island Developing States live along the coast, yet little is known about the effects of runoff from these communities on coral reefs. Here, we investigated the abundance, composition and apparent outcome of different types of coral–algae competitive interactions on lagoonal reefs in Fiji. Surveys were conducted at three sites with increasing distance from each of two rural villages. Data also included monitoring of water quality and herbivorous fish biomass. Findings revealed that declining water quality was correlated with an increase in contacts between turf algae and corals. Macroalgae were generally better competitors than corals, suggesting an ongoing community shift towards algal dominance. The most common macroalga in contact with corals was *Lobophora variegata*. Epiphytes growing on *L. variegata* increased the likelihood of an interaction being lost by the coral. Furthermore, herbivorous fish biomass decreased in proximity to villages, potentially as a result of high amounts of sediment trapped in algae. This study suggests that rural communities can shift the competitive advantage of corals towards algae, potentially initiating a transition towards algal dominance. It further underlines the importance of water quality management in Small Island Developing States so that they can continue to receive the benefits from the ecosystem services they rely on.

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INTEGRATED GENOMIC RESOURCES FOR A TEMPERATE MODEL OF CNIDARIAN-ALGAL SYMBIOSIS (Abstract ID: 29879 | Poster ID: 30)

Corals support diverse reef ecosystems, but are declining because of rising ocean temperatures which disrupt symbiosis between corals and diverse algal symbionts (genus *Symbiodinium*). The symbiont types hosted by corals contribute to thermal tolerance of the holobiont, yet the mechanisms underlying maintenance and loss of symbiosis remain poorly understood. These studies are difficult in coral because of their thermal sensitivity, restricted distributions, and cryptic variation in symbiont types. We are building genomic resources for a temperate anemone *Anthopleura elegantissima* that provides a model for symbiosis and environmental stress tolerance. *A. elegantissima* presents variation in visually distinct symbiotic states, associating with a green alga (*Elliptochloris marina*), a dinoflagellate (*Symbiodinium* sp.), and occurs in an aposymbiotic state. Maintenance of associations in the thermally dynamic intertidal zone and across a wide latitudinal range is a contrast to the more thermally sensitive associations in corals. To establish genomic resources for this model, we collected anemones across their geographic range and conducted genome-wide SNP genotyping to select a relatively homozygous colony to sequence. We have constructed a draft genome assembly for *A. elegantissima* from the chosen accession. Here we describe genome assembly and annotation, genomic patterns of population differentiation across the US west coast, and our efforts to develop and integrate a genetic linkage map, transcriptome, and genome assemblies.

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BENTHIC COVER INFLUENCES THE PRESENCE OF CORAL RECRUITS WHILE NOT AFFECTING THEIR ABUNDANCE (Abstract ID: 28501)

Corals pass through three steps to recruit successfully: (1) larval production and dispersal; (2) settlement and (3) post settlement survival. The last two steps are influenced positively and negatively by benthic organisms such as algae and bryozoans. Common methods to quantify recruitment hinder conclusions on which step leads to recruitment failure because they measure recruits that pass through all steps. This study, based at Palmyra Atoll, combined recruitment data with a water flow model and measures of coral and benthic cover to determine if recruitment is driven by larvae supply or the benthic cover on the settlement tiles. Adult coral cover and water flow were used as proxies for larvae supply. We split the data into presence/absence and non-zero abundance for correlation analysis and modelling. The presence of pocilloporid recruits correlated with the tile's benthic cover and its succession stage, adult coral cover, and water flow. It was modelled by a binary logistic model that included adult pocilloporid cover, water flux from the lagoon and benthic succession stage. The abundance of pocilloporid recruits on the tiles correlated with water flow and adult coral cover. It was modelled by an ordinary logistic regression that included adult coral cover and water flux from coral dominated sites. Our results indicate that larvae supply and benthic cover on the tile influence Pocilloporid recruitment. However, the abundance of recruits is almost entirely dependent on larvae supply. Hence, changes in benthic cover affect recruitment failure but do not influence recruit abundance.

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## COMPARISON OF GROWTH CURVES OF AGE-BODY LENGTH RELATIONSHIPS OF THREE POPULATIONS OF SCARUS QUOYI ALONG THE SOUTHEASTERN COAST OF MINDANAO, PHILIPPINES (Abstract ID: 29471 | Poster ID: 256)

The parrotfish Scarus quoyi is ecologically and commercially important and widely distributed species in the Philippine seas. Sagittal otoliths of 161 individuals were analyzed to determine any differences in populations at spatial scale. Samples were collected from Pujada Bay, Saragani Bay and Davao Gulf which covers a distance of approximately 300 km within which ecological connection still exists. Age estimates were done by counting the opaque and translucent bands on the sectioned sagittal otoliths. Size-at-age plot generated via Von Bertalanffy growth functions showed close to similar growth curves for 2 of the 3 sites. The exception was Sarangani bay where fish grew faster and reached larger size than those from the other 2 sites. At maximum age of 9 years, fish samples in Sarangani bay reached 22 cm in standard length (SL) while 18 cm and 17 cm SL at age 9 and 8 for Davao Gulf and Pujada Bay, respectively. This 4 to 5cm difference in SL suggests the possibility of growth rate difference in populations of Scarus quoyi at spatial scale and a very important indicator for faster recovery or maintenance of reefs.

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## BROAD-SCALE POPULATION GENETICS OF THE HOST SEA ANEMONE, HETERACTIS MAGNIFICA. (Abstract ID: 28773)

Broad-scale population genetics can reveal population structure across an organism's range, which can enable us to determine levels of movement and connectivity. Genetic variation and differences in genetic diversity on small-scales have been reported in sea anemones, but nothing is known about their broad-scale population structure, including those that host anemonefishes, which are increasingly being targeted in the aquarium trade. In this study, microsatellite markers were used to determine the population structure of the host anemone, *Heteractis magnifica*, across nine regions in the Indo-Pacific, ranging from the Red Sea to French Polynesia. More than 280 samples were collected. In addition, two rDNA markers were used to identify *Symbiodinium* types in the samples, and phylogenetic analyses were used to measure their diversity and geographic distribution. Significant population structure was identified in *H. magnifica*, with at least three distinct genetic breaks possibly as a result of factors such as geographic distance, geographic isolation and environmental variation. *Symbiodinium*types were also affected by environmental variation and mostly reflected patterns of regional isolation seen in the host. These results suggest that management of *H. magnifica* must be implemented on a local scale due to the lack of connectivity between clusters. This study also provides further evidence for the combined effects of geographic distance and environmental distance in explaining genetic variance, even in a single biogeographic region.

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## SPECIES DIVERSITY IN THE MESOPHOTIC CORAL GENUS LEPTOSERIS: A COMBINED TAXONOMIC AND PHYLOGENOMIC ASSESSMENT (Abstract ID: 29144)

Mesophotic coral ecosystems in the Indo-Pacific are often dominated by members of the genus Leptoseris, particularly in the deepest parts of the mesophotic zone. Although recent molecular studies have shed light on the species diversity of this genus in the Hawaiian archipelago, the genus remains poorly understood when it comes to other parts of the Indo-Pacific. Here, we present a comprehensive study into the species diversity, distribution and ecology of the genus Leptoseris on the Great Barrier Reef and Coral Sea. We conducted benthic video transects and extensive specimen collections across a broad depth range (10-125 m depth) at 10 different locations in the region. Through a combined taxonomic and molecular assessment (of both host and Symbiodinium diversity) we established initial geographic and ecological patterns of diversity. These were then further assessed through an in-depth phylogenomic assessment, in which we sequenced 150 Leptoseris specimens on the Illumina HiSeq platform (using a modified RAD-seq approach), including representatives from the different taxonomic species encountered on the Great Barrier Reef and Coral Sea, as well as Hawaii and the Red Sea. This genome-wide approach successfully resolved existing taxonomic species across regions, but also uncovered substantial cryptic diversity (e.g. in L. hawaiiensis and L. scabra) and geographic divergence. Overall this study sheds light on the diversity of this genus across both shallow and mesophotic reefs, and provides a first insight into the evolutionary relationships of its members across the Pacific

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## TERRESTRIAL AND FINE SEDIMENTS NEGATIVELY IMPACT STONY CORAL HEALTH IN THE US VIRGIN ISLANDS (Abstract ID: 29981)

Sedimentation can have deleterious impacts on corals and human activities are increasing rates of fine-grained terrestrial sediment deposition to nearshore environments. However, information on natural and modified rates of sediment deposition and specific sediment characteristics that may differentially impact coral health are needed. Rates of trap deposition of total sediments, and the standard size fractions, carbonate, organic, and terrigenous sediment components were sampled on approximately monthly intervals over 3-5 years, across a range of coral reef environments in the US Virgin Islands. Along with these measurements, coral health was assessed as the prevalence of bleaching, disease, partial colony mortality, total colony impairment (all parameters combined), and coral cover. There was high variability in rates of sediment deposition but trap accumulation was highest in nearshore sites and during periods with storm activity, with site-specific characteristics relating to sediment resuspension during the winter Atlantic swell. Only the silt-clay and terrigenous sediment components significantly positively correlated with site average coral bleaching, partial mortality, and overall impairment. For each doubling of the mg cm-2 day-1 of silt-clay and terrigenous sediment there was a 10-20% increase in these coral health responses. This suggests that specific sediment characteristics are more important than total sediment deposition in predicting coral health and provides new benchmarks for determining coral health impacts from sedimentary studies.

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## MICRO-CT ANALYSIS REVEALS DEPRESSED NET CALCIFICATION DUE TO ENHANCED BIOEROSION AND REDUCED ACCRETION OF REEF SUBSTRATA AT $CO_2$ SEEPS (Abstract ID: 27953)

Ocean acidification (OA) has been experimentally shown to depress the calcification of some species and to accelerate the bioerosion of carbonate substrata. OA could

therefore upset the tenuous balance between accretion and erosion, tipping a reef system towards net habitat loss. Controlled laboratory experiments have advanced this science but lack the complexity of field settings, where the processes of accretion and erosion involve numerous interdependent functional groups with different susceptibilities to OA. Organisms within these groups may further influence each other through competition, predation, or facilitation, and the net outcome of an OA-altered carbonate budget may therefore not simply be the sum of its parts. Here, we deployed dead coral substrata for two years along an OA gradient at two carbon dioxide seeps on reefs in Papua New Guinea. We used micro-CT to separately quantify the influence of OA on accretion, macroboring, microboring, and grazing. Macroboring, primarily by annelids, was significantly enhanced in high $CO_2$ environments, and secondary accretion was lower at one of the two high $CO_2$ seeps. Grazing and microboring remained unaffected, despite strong experimental evidence for the OA-enhancement of the latter. Alkalinity anomaly incubations of these communities confirm a reduction in net calcification under high $CO_2$conditions, providing further evidence that OA will detrimentally influence the construction and permanence of coral reef habitats.

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AN ALLOMETRIC APPROACH TO IDENTIFY THE MAIN CORAL REEF BUILDERS WHILE EXPLAINING THEIR DIFFERENTIAL CONTRIBUTION TO REEF CARBONATE BUDGETS (Abstract ID: 28721)

Scleractinian corals are responsible for building one of the most diverse and productive marine ecosystems on Earth, the coral reef. Coral-reef survival in tropical oceans for the last 200 million years has relied on the mutualistic endosymbiosis established between a simple animal (Phylum Cnidaria, Class Anthozoa) and an unicellular alga, a dinoflagellate, of the genus Symbiodinium. The success of Scleractinian corals in oligotrophic tropical environments has been attributed to their extraordinary efficiency in collecting and processing light for carbon fixation, as Symbiodinium photosynthesis significantly enhances coral calcification and growth, which is critical for the maintenance of the primary framework of coral reefs. However, not all scleractinian corals can be considered coral reef builders, and many other primary producers in the reef system also have the ability to calcify. In this contribution, I present an allometric approach that describes the differential contribution of each photosynthetic calcifier to reef carbonate budgets and explains why Scleractinian corals are the main carbonate producers, but just a few species can be considered the builders of the coral reef habitat.

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LONG-TERM VARIATION IN CORAL-ASSOCIATED MICROBIAL SYMBIONTS (Abstract ID: 28265)

Many species of plants and animals harbor unique symbioses with a diverse and abundant variety of eukaryotic and prokaryotic microorganisms crucial to their health and functioning. Scleractinian corals are host to a high diversity of microbial symbionts that include dinoflagellates, protists, fungi, bacteria, archaea and acellular viruses. The dynamics of these coral-associated communities over long time frames are poorly known. Microbial communities of tagged Pocillopora acuta colonies were examined over two years at Orpheus Island, central Great Barrier Reef. Bacterial, archaeal and fungal diversity will be assessed using amplicon next generation sequencing and any temporal patterns in diversity or abundance will be discussed. Sampling will be conducted during this summer (2015-2016) to assess initial changes and potential recovery in coral-associated microbial communities before, during and after a likely bleaching event. Understanding functional and seasonal changes in the microbial community over long time frames, as well as throughout a potential major temperature stress event, will provide insight into how the coral-associated microbiome may be affected by variations in sea surface temperatures due to future climate-related environmental change, and how this may influence the health and survival of the coral host.

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PHOTOPROTECTION AND PHOTOSYSTEM II REPAIR OF SYMBIODINIUM IN HOSPITE FOR FOUR REEF-BUILDING CORALS FROM THE CARIBBEAN (Abstract ID: 29967 | Poster ID: 48)

Ecological and evolutionary success of scleractinians relies on the symbiotic association with dinoflagellates from the genus Symbiodinium. Symbiodinium uses solar radiation to contribute 95% of the metabolic requirements of the holobiont. Corals are efficient light collectors, therefore exposure to high levels of irradiance increases energetic pressure on the photosynthetic apparatus, promoting photodamage resulting in severe losses of photosynthetic activity (photoinhibition). In this study we investigated the variation of the capacity for photoprotection and repair of 4 species of scleractinian reef-building corals. Pseudodiploria strigosa showed the highest sensitivity to photodamage acumulation, but also showed the largest support for photosynthetic repair activity. The symbiont population found in Montastraea cavernosa were from the most robust symbionts in preventing the accumulation of photodamage, but have the lowest repair activity, resulting in large levels of photodamage under increasing levels of excessive absorbed energy. Orbicella faveolata and O. annularis showed the highest symbiont concentration, which allowed for photoprotection (self-shading), except under conditions of low pigmentation or rapid cell loss. We defined two different descriptors that allowed for quantification of differences in the photoprotective capacity of Symbiodinium in hospite. First, a fast component that can be assimilated to the NPQ descriptor proposed for green algae and higher plants, and the second a slower component related to the quenching of F0 in the antenna of Symbiodinium.

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ASSESSMENT OF SHARKS CAUGHT BY CORAL REEF FISHERS IN THE PHILIPPINES (Abstract ID: 29811)

Removing apex predators like sharks from the wild has cascading effects on the marine ecosystem. They are considered as keystone species and have experienced decline for the past decades, resulting in various management planning and educational campaigns by concerned groups for their population recovery. Despite the reduction in shark fin production and exports, shark fishery is still on going and largely remains unregulated and unmonitored. On-going fisheries assessments in several cities/municipalities across the Philippines under the National Assessment of Coral Reef Environments (NACRE) Program provided an important opportunity to determine the status of sharks caught by coral reef fishers in the areas. Focus group discussions (FGDs) and semi-structured interviews conducted in at least six coastal barangays each in 17 cities/municipalities were used to evaluate whether the fishers also target sharks. Results show that sharks are usually caught as by-catch using various fishing gears while fishers in some sites use spe-argun or modify fishing techniques to deliberately catch them when present. Aside from their fins, meat and oil, sharks are also being targeted for the aquarium industry. Sharks are highly vulnerable to overexploitation which prompts the need to increase awareness as regards the ecological consequences of local extinction in the Philippines, as well as to improve shark fisheries management.

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GENOMIC AND BIOCHEMICAL CHARACTERIZATION OF C-TYPE LECTINS IN A MODEL CNIDARIAN AND THEIR ROLE IN SYMBIOSIS ESTABLISHMENT (Abstract ID: 28430 | Poster ID: 106)

The cnidarian-dinoflagellate symbiosis is highly specific: a given host can establish symbiosis with only a subset of Symbiodinium types. However, the molecular mechanisms underlying this specificity remain poorly understood. Several studies have suggested that recognition of compatible Symbiodinium during symbiosis establishment depends on the binding of host lectins to glycans on the dinoflagellate cell surface. Using the anemone Aiptasia as a model system, we have identified several genes encoding lectin-like proteins that are expressed differentially between symbiotic and aposymbiotic anemones. One such gene, encoding the C-type-lectin(Ctl)-like protein Ctl1, shows 8-fold higher expression in aposymbiotic animals. We expressed a recombinant, GST-tagged Ctl1 in bacteria and found that it binds much more strongly to an incompatible than to a compatible strain of Symbiodinium in vitro, consistent with a role in the discrimination between symbiont types. However, eukaryotic Ctl-like proteins may be misfolded after expression in bacteria, so that we are currently attempting to express recombinant Ctl1 also in a eukaryotic system, the yeast Pichia. In addition, the Aiptasia genome sequence revealed that Ctl1 is one of a set of related lectins originating from at least six genes in a tandem array. However, gaps in the sequence have made these loci difficult to resolve. Using PacBio long sequencing reads, we are now attempting to fill these gaps so as to define the full diversity of the Aiptasia Ctl proteins, whose binding properties can then be explored.

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STRENGTHENING MARINE PROTECTED AREAS TO CONSERVE MARINE KEY BIODIVERSITY AREAS IN THE PHILIPPINES – THE MKBA PROJECT (Abstract ID: 28547)

An evaluation of the management effectiveness of marine protected areas (MPAs) in the Philippines to address key drivers and pressures identified 3 major challenges in conservation and management of marine resources. These are (1) inadequate species, ecosystems and spatial coverage representation, (2) insufficient and unpredictable funding levels for long-term management, and (3) weak enabling policy framework for marine biodiversity conservation. The Marine Key Biodiversity Areas (MKBA) Project, a 5-year project, was designed to address these challenges and uses an integrated ecosystem approach to strengthen the conservation, protection and management of marine key biodiversity areas in 5 demonstration sites (i.e., Verde Island Passage, Southern Palawan, Tañon Strait Protected Seascape, Lanuza Bay and Davao Gulf) in partnership with key national government agencies, national and local conservation non-government organizations and local government units. The project outcomes include increased management effectiveness of MPAs and MPA Networks, improved financial sustainability and an established enabling policy framework for marine biodiversity conservation. A wide range of activities is undertaken in each of the sites to demonstrate site-specific and integrated approaches for effective marine biodiversity conservation. An important strategy is combining social, governance and ecological components in scaling up the management of existing MPAs to form functional networks. Important metric indicators are used to monitor and evaluate progress of the project.

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RESOURCE PARTITIONING AND TROPHIC RELATIONSHIPS OF LARGE PREDATORY FISHES IN A CORAL REEF ECOSYSTEM (Abstract ID: 28720)

Sharks are thought to play an important role in structuring coral reef communities, but their role may be masked by the high level of functional redundancy. For example, coral reefs have a high diversity of predatory fishes that could be sharing similar ecological roles. Therefore, a better understanding the feeding ecology and trophic interactions of large predatory fishes may help define their role within coral reefs. This study used stable isotope analyses to examine trophic relationships and niche overlap of common reef predators in the central Great Barrier Reef. Mean trophic position of reef predators (sharks and teleosts) increased with body size, with larger sharks having higher trophic positions than smaller teleosts. However, sharks typically differed in their mean isotopic values (δ13C and δ15N), and most species examined occupied a relatively unique isotopic niche space. The only exceptions were grey reef (Carcharhinus amblyrhynchos) and silvertip sharks (C. albimarginatus), which showed high degree of isotopic niche overlap. The bull shark (C. leucas), a large seasonal predator, appeared to feed higher in the food web than resident sharks. In contrast, the whitetip reef shark (Triaenodon obesus), a species with strong site-attachment, had similar isotopic niche spaces than smaller teleost predators (Plectropomus leopardus and Lethrinus miniatus). Our findings suggest that although reef sharks occupy relatively high trophic positions, larger non-resident species may be more important in the functioning of coral reef communities.
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CONSERVING THE MARINE ENVIRONMENT OF MALUKU BARAT DAYA: A SCENARIO ANALYSIS OF PAST AND FUTURE TRENDS (Abstract ID: 28665 | Poster ID: 677)

The recent establishment of Maluku Barat Daya as a new regency of Maluku province, Indonesia, in 2008, has opened the doors for economic development and population growth. Here, we describe qualitatively the past, present and future trends of environmental impacts on the coastal zone of Maluku Barat Daya to formulate the best management options in light of current and future political conditions. Focus group discussions, key-informant interviews and participatory mapping were carried out in fourteen sample settlements in November 2015 through rapid assessment. Scenario analysis was applied to draw four plausible trajectories of future change until 2035. The exploitation rate of marine resources in Maluku Barat Daya has been stable throughout the past few decades, due to limited access to the market. Traditional and undestructive fishing gears were still commonly used. While traditional fisheries closure system (sasi) is the primary form of marine resource management across all settlements, although it has been strongly influenced by buyers and prices. Social, economic and marine resource use conditions were varied in the future under four different scenarios. Based on future prediction, it is important to design the most suitable management option that can reduce and maintain future environment impacts, while preserve local custom.

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GLOBAL BIOGEOGRAPHY OF MARINE ALGAE WITH APPLICATIONS FOR CORAL REEF CONNECTIVITY (Abstract ID: 29568)

The global distribution patterns of marine benthic algae were analyzed with respect to latitudinal and longitudinal gradients, temperature, spatial scales, taxonomic gradients, and patterns of endemism. Global presence/absence records of marine algae were collected from online resources, scientific papers, and gray literature and compiled into a digital database of 131,400 records, with 52,680 unique species-locality records occurring after geographic and taxonomic filters. Records were grouped into 155 unique localities, which were further classified into three temperature regions (temperate, subtropical, and tropical) based on NOAA/NCEP SST data. The Tripartite Similarity Index was used to measure percent similarity between all locality pairs (excluding the Antarctic and Arctic localities), with minimal distances between all locality pairwise combinations calculated by implementation of Dijkstra's algorithm for shortest path problems along a modeled connectivity network. Analyses of variance and covariance were used to ascertain differences in regression patterns between locality records clustered along temperature, geographic, or taxonomic gradients. Endemism metrics were calculated by a corrected weighted measure using two methods: as the proportion of range-restricted species in each 5-degree cell and by localities alone, revealing many regions of endemism ignored previously. Marine algal biodiversity patterns were compared with those for corals and shore fishes. Connectivity patterns for algae have applications for coral reef conservation globally and for MPA design.

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USING REEF FISH MOVEMENT INFORMATION TO IMPROVE MARINE RESERVE DESIGN IN POHNPEI, MICRONESIA (Abstract ID: 28039)

Designing reserves must be adequate to ensure the persistence of focal species. Guidelines recommend that minimum reserve size be informed by species' home ranges. We used recently published information on the home ranges of coral reef fishes to inform the design of marine reserves in Pohnpei, Federated States of Micronesia. Key species of interest were identified at an initial stakeholder workshop. Communications products illustrating which species were likely to be afforded protection within existing reserves were used to facilitate discussions about the efficacy of the reserve system with stakeholders. Combined with information on management effectiveness, this information was used to identify which reserves should be prioritised for improving design and/or management. Almost all reserves were found to be too small to adequately protect key species of interest. Though legislation makes it difficult to change the boundaries of existing reserves, recently proposed reserves are larger, and afford greater protection to key species. Furthermore, communities are considering other mechanisms to improve reserve design, for example through larger seasonal closures. Previous approaches to determining marine reserve size have been a trade-off between a conservation mantra of "bigger is better" and social acceptability, with resource users preferring smaller closures. Our approach of using movement patterns of locally important species to determine appropriate reserve sizing resonated more with resource users and better engaged them in the design process.
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THE DAMSELFISH DOMINO EFFECT: A COMPETITIVE RELEASE IN A HIGHLY PARTITIONED GUILD REVEALS SUBORDINATES VERSATILITY (Abstract ID: 29078)

Territorial damselfish play an integral role in the structure of coral reefs through their abundant role as small-bodied consumers and aggressive holders of benthic space. Their interactions towards inter- and intraspecific competitors influence the overall community and how resources are partitioned. In Kimbe Bay, PNG, 7 territorial damselfish finely partition space along the reef profile in discrete zones with semi-overlapping perimeters. Previous research suggested that habitat preference alone was insufficient in explaining the distributional patterns and that competition may be an additional driver. This study quantified how subordinates ecological versatility and spatial distribution was altered after an experimental competitive release. 22m by 10m removals of the most abundant species, Pomacentrus adelus, were conducted to assess subordinates versatility and spatial ecology. After removing P. adelus, the surrounding interspecific competitors shifted consecutively into the space previously occupied by P. adelus adults. Movement was observed immediately following the removal and the acquired space was retained 6 months post-removal at higher densities. P. adelus did not regain its original distribution despite recruitment. Thus, demonstrating that competition is a major driver behind fine-scale partitioning and that species can become versatile and alter ecological parameters if competition is decreased and additional space is available. This is ecologically important as habitat loss may force specialists to adapt or move into previously unoccupied areas.

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QUANTIFYING THE EFFECTS OF OCEAN ACIDIFICATION ON THE RECOVERY OF CORAL COMMUNITIES (Abstract ID: 28421)

The response of corals to ocean acidification (OA) has been widely studied, with OA predicted to reduce coral reef calcification worldwide. However, coral performance is governed by both abiotic and biotic factors, although only a few studies have investigated OA affects on multiple coral species. We use a spatially-explicit model of coral community dynamics to explore how OA and coral-coral competition affect coral growth (calcification, extension, and density), and how these effects translate to community-level consequences on a reef recovering from disturbances. The model is parameterized using field data and flume experiments from Moorea, French Polynesia, and projections are used to test for different outcomes resulting from competitive dominance attributed to species- or size- effects under ambient conditions. We then include the effect of OA on colony growth, and evaluate its community-level impacts as the frequency of coral-coral competition increases during community recovery. Lastly, we explore the interplay of competition and OA on coral communities with the inclusion of future disturbances, assuming differential risk of dislodgment with changing skeletal density. While coral interactions act synergistically with pCO2 in reducing the skeletal extension of corals and their ability to compete for space, simulations revealed that conspecific aggregations benefit community recovery by mitigating the negative effects of OA. Our results stress the difficulty in predicting community responses to OA due to the complex influence of abiotic and biotic factors on corals.

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GENOTYPING-BY-SEQUENCING REVEALS LACK OF STRUCTURE IN THE DEEP-SEA OCTOCORAL SWIFTIA SIMPLEX (NUTTING 1909) ON THE WESTERN COAST OF THE UNITED STATES (Abstract ID: 28826)

Deep-sea corals provide important habitat in the deep ocean and have been recognized as regional hotspots for biodiversity. Despite their ecological importance, little is known about the connectivity and life history of deep-sea octocoral populations. An understanding of the population structure of deep-sea corals is critical to ascertaining the effects of habitat loss and genetic connections between distant populations. Next generation sequencing, including restriction site-associated DNA (RAD) sequencing, has allowed the discovery and application of thousands of novel single nucleotide polymorphism (SNP) markers in non-model species, including marine invertebrates. In this study we utilized high-throughput RAD-tag sequencing to develop the first molecular resource for the deep-sea octocoral Swiftia simplex (Nutting 1909). Using this technique we discovered thousands of putative genome-wide SNPs from twenty-three S. simplex individuals collected along the U.S. West Coast. After quality control, we successfully assayed 1,145 SNPs across all individuals, and analyzed the resulting multi-locus genotypes to assess putative population structure across the region. Across all areas, no geographic genetic structure was detected for this species, suggesting a high degree of connectivity and potential panmixia along the U.S. West Coast.

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PHOTOACCLIMATION AND INDUCTION OF LIGHT-ENHANCED CALCIFICATION IN THE MESOPHOTIC CORAL *EUPHYLLIA PARADIVISA*(Abstract ID: 28808)

Depth gradient is characterized by inherent changes in light which lead to several adaptation strategies within corals and their symbionts. In this study, the strictly mesophotic coral *Euphyllia paradivisa* from the Red Sea served as a model to determine the strategies of acclimation to different light conditions and to study photosynthesis and calcification coupling. The coral's physiology was examined after one year of acclimation under three sets of light conditions: shallow (3m); deep (50m, native population); and total darkness. Although photosynthesis was almost similar at both light treatments under a P vs. E curve, light enhanced-calcification was evident only in shallow acclimated corals leading also to six fold larger linear extension rates. The dark treated specimens were completely bleached and photoacclimation to shallow was expressed in enhanced respiration, higher zooxanthellate densities per polyp and lower chlorophyll per cell. We discuss the adaptation mechanisms of mesophotic corals to shallow water and to the aphotic zone. We conclude that *E. paradivisa* can adapt to various light conditions by controlling metabolic rates and growth energy investment and therefore can survive temporal and spatial effects of low light stress. It is generally accepted that ecological advantages acquired by corals in their native habitat may jeopardize their survival in a case of abrupt environmental changes. However to the strictly mesophotic *E. paradivisa* in the Red Sea shallow waters may be advantageous.
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INDIVIDUAL ANNUAL FECUNDITY AND REPRODUCTIVE ENERGY INVESTMENT IN MUSHROOM SCLERACTINIAN CORALS (Abstract ID: 28800)

Reproductive investment and growth are often used as indicators of health or stress at the organism level. Knowledge of how such energy investment varies intrinsically among species or morphological types is crucial for the interpretation of physiological responses to environmental factors. Patterns of energy allocation may change in accordance to the degree of sexual maturity of the individual and are often size-dependent processes. Insight into the allocation of energy to reproduction and growth is central to understanding both the life-history strategies of species and the physiological tradeoffs of individual organisms since the reproductive energy allocation strategy affects virtually all other life-history traits. Due to their wide range of module sizes, colony growth forms, and life-history characteristics, scleractinian corals provide an important opportunity to assess how the relative allocation to sexual reproduction relates to morphology, size, and life-history strategies. We examined the reproductive activity and energy investment of two mushroom scleractinian corals, bearing different reproductive strategies; Fungia fungites and Herpolitha limax and surveyed the size frequency distribution of the fungiid populations in their natural habitat in the coral reefs of Okinawa, Japan. Fecundity was found to be highest at middle size (i.e. middle ages) and decline at older ages; sex ratios were more female-biased at middle ages than in early and late life ages and the middle size group showed high settlement rates in comparison to other size groups.

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HOW MORTALITY PATTERNS INFLUENCE THE COMPOSITION OF SCLERACTINIAN CORAL COMMUNITIES (Abstract ID: 29931)

It is commonly accepted that coral reef ecosystems possess two dynamically stable states: one dominated by reef-building corals, and another dominated by fleshy algae. The transition between these states has been linked to alterations of herbivore assemblages (e.g. fishing, marine protection), in addition to other environmental forcings. Importantly, global climate change may impact coral reef community trajectories without necessarily leading to the either of the previously described states. Coral communities may suffer mortality from storm events, bleaching, crown-of-thorns starfish outbreaks, disease, sedimentation and anthropogenic destruction. These mortality events represent both local (e.g. reef, island) and global (e.g. archipelago, oceanic basin) phenomena. Understanding how different types of mortality shape coral communities is necessary to better elucidate ecological consequences of global and local stressors. Here, we use a numerical modeling approach to describe how these stressors affect mortality patterns and ultimately shape coral community composition. Importantly, we identify key parameter ranges that define the structure and composition of coral assemblages. In particular, we demonstrate that intense local stresses overwhelm the signature of global impacts by decoupling the functional linkage between morphological characters of coral and nuanced effects of oceanographic events. Such information allows us to explore the possible consequences of changes in mortality patterns and allow us to anticipate its short-term transformation in a changing world.

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GLOBAL RESPONSE OF CORAL REEF BENTHIC CALCIUM CARBONATE DISSOLUTION TO OCEAN ACIDIFICATION (Abstract ID: 27791)

Ocean acidification (OA) is predicted to have a significant impact on the future of coral reefs, mainly through the reduced formation of calcium carbonate (CaCO3). However, the dissolution of stored CaCO3 has largely been overlooked in the OA community. CaCO3 sediments represent the largest reservoir of carbonate minerals in coral reefs and result from the accumulation and storage of CaCO3 material over thousands of years. This presentation will demonstrate the in situ drivers of dissolution in coral reef carbonate sands and how they will respond to increasing average pCO2 (ocean acidification). In situ benthic incubations at coral reefs around the world show that aragonite saturation in the overlying water is a strong predictor of CaCO3 sediment dissolution and most reefs show a similar response to increasing average pCO2 (OA). However, every reef shows a different net sediment dissolution starting condition and the effect of end of century OA conditions on net sediment dissolution is different for every reef. The rate at which sediments are predicted to dissolve by the year 2100 has important implications on the net accretion of coral reefs and their future survival. Quantifying the global dissolution kinetics of CaCO3 sediments is clearly just as important as estimating calcification rates when predicting how OA will impact coral reef ecosystems.

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PHOSPHORUS AS A KEY NUTRIENT FOR THE MAINTENANCE OF THE CORAL-DINOFLAGELLATE SYMBIOSIS DURING THERMAL STRESS (Abstract ID: 28332)

The current warming of the oceanic surface waters induces profound modifications of the biogeochemical cycles and of the diversity of marine ecosystems all over the world. In addition, massive bleaching events (symbiont/pigment loss) were observed in nutritional autotrophic symbioses, such as the coral-dinoflagellate one, that dominates tropical benthic ecosystems. As dinoflagellates provide the host with most of its daily energetic needs, their release during bleaching events induces host starvation. However, except for carbon, the nutritional impact of bleaching has poorly been investigated, especially regarding the needs in inorganic nutrients such as nitrogen and phosphorus. This study assessed the capabilities of four hard (clade C1) and one soft (clade D1) tropical coral species to acquire essential inorganic nutrients (NH4, NO3 and PO4) under normal (25°C) and thermal-stress (30°C) conditions. Results showed differences in thermal threshold and nutrient acquisition rates among coral holobionts. More, under thermal stress, all species bleached and most of them lost their ability to acquire nitrogen, closely linked to their photosynthetic capacities. However, phosphorus (P) demand largely increased for most of the holobionts at 30°C. This global response is linked to the beneficial effect of P in sustaining optimal rates of photosynthesis and carbon translocation as well as symbiont density. Broadly, this study highlights phosphorus as a key nutrient for the maintenance and resilience of the holobiont under thermal stress-inducing bleaching.

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FISH, TRADE AND FOOD SECURITY: MOVING BEYOND THE 'AVAILABILITY' DISCOURSE IN MARINE CONSERVATION (Abstract ID: 27978)

The goal of food security increasingly serves as an objective and justification for marine conservation in the global south. In the marine conservation literature this potential link is seldom based upon detailed analysis of the socio-economic pathways between fish and food security, is often based on limited assumptions about increasing the availability of fish stocks, and downplays the role of trade. Yet, the relationship between fish and food security is multi-faceted and complex, with various local contextual factors that mediate between fish and food security. We use data from interviews and food security assessment methods to examine the relationship between fish and food security among fishing households in San Vicente, Palawan province, Philippines. We highlight the local role of income and trade, emphasising the sale of fish to purchase food not easily accessible for fishers, particularly staples. In particular, we show that because rice is the primary staple of food security for these households, fish must be traded with the intent of buying rice. Trade is therefore central to household food security. We argue that the relationship between fish and food security must be considered in greater depth if marine conservation is to engage with food security as an objective.

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$CO_2$ SEEPS IN PAPUA NEW GUINEA AS A NATURAL LABORATORY TO INVESTIGATE THE EFFECTS OF OCEAN ACIDIFICATION ON CORAL RECRUITMENT (Abstract ID: 28827)

Predicting the ecological consequences of rising atmospheric $CO_2$ for marine communities remains a key knowledge gap. We have investigated coral recruitment processes at shallow volcanic $CO_2$seeps in Papua New Guinea, where nearly pure $CO_2$ gas is bubbling out of the sea floor. We studied (1) coral fecundity, spawning, larval settlement and recruitment success of in situ acclimatized *Acropora tenuis* corals on acclimatized settlement substrata, (2) recruit densities of all coral taxa along $CO_2$gradients on artificial settlement substrata after 5 and 13 months deployment, and (3) densities of coral juveniles at high $CO_2$ and control sites in the field. The experiments and surveys documented significant reductions in coral recruitment at high $CO_2$. Importantly, $CO_2$-acclimatised*A. tenuis* colonies showed the same level of reduction in recruitment success to non-acclimatised colonies. Our experiments in combination allowed us to identify some of the likely underlying mechanisms that were responsible for the observed reduction in recruitment success. They also show that major ecological changes, and not just physiological challenges, will strongly contribute to determining the resilience of shallow-water coral reefs in a future high-$CO_2$ world.
http://http://www.aims.gov.au/research/climate-change/ocean-acidification/co2-seeps

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DEVELOPMENT OF A SUBTROPICAL, VOLCANIC GEOLOGY-SPECIFIC MODEL FOR SEDIMENT DELIVERY IN THE HAWAIIAN ISLANDS (Abstract ID: 29609)

Human induced accelerated erosion and transport of sediment to the coastal zone threatens coral reef systems. Sediment export data at the island scale would be useful to research efforts that distinguish between the effects of different land-based source pollutants on volcanic islands, but is typically not available. We used the InVEST sediment model, an open source, annual, RUSLE-based model based on the idea of the sediment delivery ratio, with modified cover and erodibility factors, custom stream delineation, and a new factor termed "terrain factor" to account for geologic differences. We calibrated the model based on annual sediment loads for 12 watersheds with daily USGS data, and validated the model with 42 additional watersheds. Using this model, we predicted sediment export for 817 watersheds that discharge to coastal waters. We found that annual sediment export ranged from 26 to 273 ton/km2/yr, by island, and the calculated SDR ranged between 1.1% and 10.4%. Understanding geologic differences between islands was critical. A correlation analysis showed watershed parameters slope, rainfall and elevation to be responsible for the majority of variability, while the SDR was correlated more directly to soil erodibility. Results from this model are the first state-wide estimates of sediment export. The parameterizations and calibration from this study will be useful for land-use managers looking to understand the spatial nature of sediment export and how land use changes might impact erosion and sediment that eventually is deposited in coastal waters.
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CORAL COMMUNITY STRUCTURE OF CORAL REEFS IN SOUTH CHINA SEA AND TAIWAN: CURRENT STATUS AND CONSERVATION ACTIONS (Abstract ID: 27929)

Global coral reefs have been declined in the past several decades. It is critical to understand the current status of coral reefs and execute conservation actions. The benthic community structures were surveyed by phototransects at 38 sites in areas of Taiping (Spratly) island and Dongsha atoll in South China Sea as well as Hengchun peninsula, Hsiaoliuchiu and Penghu islands in Taiwan during March 2013 to April 2014. The mean cover of hard coral at all sites was 42.7% with that of hard coral at each site ranged from 12.3% to 74.1%. Six coral community types were characterized by dominant growth forms and genera. They are branching *Acropora*dominant, foliaceous *Montipora* dominant, foliaceous *Pavona* dominant,*Heliopora* dominant, foliaceous *Echinopora* – massive *Porites* dominant, and soft coral dominant communities. The major disturbances, conservation value and protection actions in the 5 areas were compared to enhance management effectiveness.

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EFFECTS OF OIL DRILLING DISCHARGES ON NET OXYGEN AND NUTRIENT FLUXES OF THE ARCTIC-BOREAL SPONGE *GEODIA BARRETTI* (Abstract ID: 29750 | Poster ID: 324)

The arctic-boreal sponge *Geodia barretti* Bowerbank, 1858 is widely distributed on cold-water coral reefs, playing a key role in carbon and nutrient cycling. With expanding oil exploration in arctic-boreal regions, this study aimed to investigate the effects of barite and bentonite, which are commonly discharged during oil drilling operations, on the sponge. Explants of *G. barretti* were exposed to suspended barite and bentonite, as well as natural sediment, at a mean concentration of 10 mg $L^{-1}$ under a 12-hour daily exposure cycle for 33 days. On day 33, net uptake of oxygen by *G. barretti*explants from ambient seawater significantly decreased by at least 26% in the three treatments compared to the control. The reduced net oxygen uptake was accompanied by at least 28% decrease in relative oxygen content within *G. barretti* explants from all treatments, as measured by a needle-type oxygen microsensor. However, net uptake or release of silicate, ammonium, nitrate and nitrite by the explants were not significantly different among the control and treatments. The exposure period was followed by a recovery period of 33 days under control conditions. After the recovery period, parameters measured across all treatments were not significantly different from the control levels. Overall, this study demonstrated (1) the effects of barite, bentonite and natural sediment leading to less oxic conditions within *G. barretti* explants, and (2) the ability of *G. barretti* explants to recover from the effects. Our findings provide insight into ecological consequences of oil drilling activities in arctic-boreal regions.

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CRYPTIC SPECIES AND PHYLOGEOGRAPHIC PATTERNS AMONG RED SEA AND WESTERN INDIAN OCEAN GIANT CLAMS (Abstract ID: 29297)

Most of the phylogeographic work on giant clams has been conducted in the Coral Triangle and adjacent regions. Much less attention has been paid on the four species from the western Indian Ocean (IO), Tridacna squamosina (endemic to the Red Sea), T. rosewateri (endemic to the Mascarene Plateau) and the Indo-Pacific distributed T. maxima and T. squamosa. We investigated the phylogeography of the two latter, sampled from Farasan islands (Red Sea), Glorieuses, Juan de Nova and Tulear (Mozambique channel), Reunion Island and Rodrigues (Mascarene Islands). A total of 430 clams were photographed, biopsied and genetically analysed using COI and 16S mitochondrial sequences, as well as 14 microsatellite loci for T. maxima. Preliminary results revealed a highly divergent lineage, distributed from Juan de Nova to Reunion Island. Phylogenetic analyses placed it as a sister clade of T. squamosina, pointing to cryptic speciation. Its morphological similarity with T. squamosina suggests that speciation originated by vicariance. A deep phylogeographic break was further found between Red Sea and the west IO populations of both T. maxima and T. squamosa. For T. maxima, the western IO population showed further division into two divergent clades with narrow latitudinal range overlapping in the Mozambique Channel. At the south west IO scale, T. maxima showed strong nuclear divergences among populations suggesting highly restricted dispersal rates, a surprising result considering its wide distribution range. Altogether, our results confirm that the western IO is a biodiversity-rich, yet neglected region of the Indo-West Pacific. Further phylogeographic work is warranted.

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THE ROLE OF EARLY LIFE-HISTORY DYNAMICS IN THE RECOVERY OF A KEYSTONE HERBIVORE, DIADEMA ANTILLARUM, FOLLOWING RECURRENT DISEASE OUTBREAKS IN THE FLORIDA KEYS (Abstract ID: 28194)

Mass mortality due to disease of the abundant herbivorous sea urchin*Diadema antillarum* in the tropical western Atlantic and Caribbean in 1983–84 resulted in dramatic changes in coral reef ecosystem structure and functioning. Many shallow reefs shifted from a coral- to macroalgal-dominated ecosystem, due to the removal of this important grazer. Recovery of *Diadema* has led to localized shifts back towards coral-dominated reefs. However, in the Florida Keys, where a second disease outbreak in 1991 further depressed densities, *Diadema* remain relatively rare. It is possible that at early life-history stages, positive feedbacks for the algal-dominated state inhibit *Diadema* recovery. We test this by characterizing fertilization and settlement dynamics of Diadema across sites with variable habitat cover in the Middle Keys. We use a combination of field and modeling studies to identify factors limiting *Diadema* recovery and to determine the impacts of habitat type on recovery potential in the Florida Keys. Our results indicate that a severe depression of local fertilization rates (< 5%) occurred following disease and continue today. Despite this, we observed active settlement in summer 2015 suggestive of re-colonization from distant populations. Comparisons with habitat cover indicate selective settlement behavior, with a trend of higher settlement in algal- versus coral-dominated regions, which could destabilize the algal-dominated state. However, post-settlement processes, such as predation, may prevent settlers from reaching adulthood.

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MONITORING AND CONSERVATION OF REEF FISH POPULATIONS IN SOUTH FLORIDA NATIONAL PARKS (Abstract ID: 29775)

The National Park Service (NPS) in collaboration with partner agencies and universities monitor reef fish populations in six ocean parks in Florida and the U.S. Virgin Islands. Fisheries independent monitoring protocols have been developed to provide spatially explicit population metrics such as abundance and size structure to evaluate the effectiveness of fishery managed protected areas. Streamlining the reporting process for regionally important species is in development so annual "quick look" reports can be used by parks to assess fisheries management strategies and direct management decisions. NPS units are generally not created to specifically conserve fish populations, yet can function as valuable management tools to sustain healthy population metrics and allow more fish to be available for capture in open fished areas. Reef fish population monitoring in the Dry Tortugas, Florida region with large no-take marine reserves, show enhanced reef fish populations. While in contrast, management by traditional length and bag limit regulations in the Biscayne National Park region show depleted and possibly unsustainable snapper and grouper populations, with a collapse of historical spawning aggregations. For example, mean length (35.5 cm +/- 5.2 se) and frequency of occurrence (0.09 +/- 0.03) of Biscayne*Lutjanis analis* were significantly below values for the Dry Tortugas (46.3 +/- 1.8 and 0.29 +/- 0.04 respectively). These factors have a significant effect on individual fecundity and the reproductive potential of the population.

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METHODOLOGY TO SCREEN CHEMICALS FOR THEIR POTENTIAL BLEACHING EFFECTS ON CORALS: APPLICATION TO UV FILTERS (Abstract ID: 28739 | Poster ID: 495)

Some studies have reported that certain UV filters contained in sunscreen lotions and washed off by swimmers, could trigger coral bleaching. Suspicion has been extended to all organic UV filters present in sunscreens products. The present study aimed at investigating the potential effect that organic UV filters may have on different coral species. Two herbicides were used as positive reference compounds. A preliminary rapid screening test was developed to assess the potential adverse effect of short exposure (48h) to elevated UV filters concentrations (from 1 to 100 mg/L), on nubbins of the hard coral species Seriatopora caliendrum and Stylophora pistillata. As a sub-lethal endpoint predictive of coral bleaching, the photosynthetic efficiency of the photosystem II of the symbiotic microalgae (zooxanthellae) was monitored by continuous measurements using PAM (Pulse Amplitude Modulated) fluorimetry. Coral nubbins of Stylophora pistillata and Turbinaria reniformis were then exposed for 5 weeks at lower, but still higher concentrations than those reported for natural sea waters, in 15-liters aquariums. Nubbins were exposed in closed-circuit aquarium with weekly seawater renewal. A specific analytical methodology was developed, combining automated solid phase extraction with UPLC-UV detection, to monitor the water UV filters concentrations, all along the exposure period. Dose-responses curves generated with these organic UV filters will be presented and compared with the one generated with mineral sunscreens.

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INFERRING SEDIMENT TRANSPORT USING LARGE BENTHIC FORAMINIFERA: COMPOSITION, TAPHONOMY AND GEOCHEMICAL PROXIES (Abstract ID: 28895 | Poster ID: 241)

Coral reef geomorphological processes are responsible for landform evolution, habitat change and sediment dynamics. Understanding reef sediment transport allows insight into antecedent processes and future landform responses. Large Benthic Foraminifera (LBF) live in the algal rim and deposit tests (shells) which are transported by hydrodynamics (eg. waves, currents). Due to well-defined source areas, LBF tests may act as a 'tracer' to infer sediment transport pathways. We analysed surficial (n=74) and down-core (n=97) samples from two sand aprons at One Tree Reef, in the southern Great Barrier Reef (Australia). LBF tests (*Baculogypsina sphaerulata* and *Calcarina* spp.) exhibited increased abrasion ($r_s$=0.60, p<0.001) with cross-reef lagoonward transport. Transport trends were consistent with wave direction and refraction. Down-core and surficial sediments were spatially consistent suggesting transport conditions have prevailed for the last 3 ka. While the effectiveness of LBF as tracers has been proved in this and other studies, low abundance remains a limitation. We propose elemental ratios using LBF tests as a novel proxy for determining sediment transport pathways. LBF test analysis (n=40) revealed decreased Mg/Ca and increased Sr/Ca with lagoonward transport. Mg/Ca ($R^2$=0.83, p<0.001) and Sr/Ca ($R^2$=0.32, p<0.001) ratios were significantly correlated against abrasion, suggesting a link with test alteration. This novel proxy is rapid, requires minimal materials and provides quantitative measures for LBF test alteration.

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AN INTRODUCTORY COMPARISON OF THE IUCN RED LIST AND THE U.S. ENDANGERED SPECIES ACT (Abstract ID: 29923 | Poster ID: 694)

Coral reef scientists have not paid much attention to whether there may be endangered species on coral reefs until recently. It appears that knowledge of the differences between the IUCN Red List and the U.S. Endangered Species Act (ESA) is not widespread. There are a variety of basic differences, such as the IUCN Red List being international but only advisory, while the U.S. Endangered Species Act is a U.S. federal law which thus applies only in the U.S., but is an enforceable law. The IUCN Red List has extensive instructions and detailed, quantitative rules for applying a set of several terms indicating different levels of danger. The ESA however has only a few vague terms without any quantitative rules or extensive instructions, and even the basic terms have required judicial rulings to clarify. Also, the Red List rules explicitly encourage applying the precautionary principle, while the ESA forbids using it in making listings, but allows it for management actions. Some of the basic differences between these two systems will be explored in this presentation.

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EVALUATION OF RETICULATE EVOLUTION IN CORAL REEF FISHES USING GENOME SEQUENCING (Abstract ID: 30115)

Coral reefs in the margins of biogeographic regions present unique conservation challenges and opportunities. Phylogeographic and biogeographic surveys of coral reef fishes have revealed the importance of peripheral locations in generating endemic species or lineages, and connectivity studies reveal that marginal coral reef may largely contribute to species persistence as sources of propagules in demographic feedbacks that connect populations over vast geographic distances. Furthermore at the edges of biogeographic regions, closely related species may come into secondary contact and interbreed. It has recently been well documented the presence of marine suture zones, where sister species of different faunal affinities overlap and hybrids with intermediate coloration are common. Although visual observations and preliminary genetic data suggest that the hybrids are fertile and interbreed, reticulate evolution in reef fishes and its evolutionary consequences are yet to be evaluated. To this aim, we investigated in various species complexes of Indo-Pacific reef fishes and applied a RADSeq approach to genotype individuals of parental individuals and hybrids from natural populations at thousands of Single Nucleotide Polymorphism (SNP) loci. Our results confirm the presence of hybrid individuals and suggests that ancient and ongoing introgression are substantial evolutionary forces shaping the evolution of coral reef fishes.

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QUANTIFYING ANNUAL CORAL GROWTH AND EROSION USING 3D MODELS (Abstract ID: 29024)

Habitat structural complexity is the 3D structure of an ecosystem that underpins biodiversity and resilience to disturbance. In coral reefs scleractinian corals are the key habitat builders providing most structure. Corals have slow growth (a few mm – cm per year) and their growth follows a multidimensional trajectory. The capacity to detect change in the 3D structure of coral colonies relies on highly accurate and precise metrics capable of capturing the three-dimensionality of an object. This study used state-of-the-art 3D technologies to quantify annual coral growth and erosion of table corals in situ. We used photogrammetry to reconstruct 3D models of both dead and live colonies from underwater images in 2014 and 2015. We used the 3D models to measure change in both volume and surface area after 12 months. Live corals grew by 20.5 ± 10.5 % (mean ± SE) of their original volume and 21.7 ± 6.6 % of their original surface area, while dead colonies shrunk by 52.2 ± 7 % of their original volume and 47 ± 6.8 % of their original surface area. Measurements were precise to 1% coefficient of variation. This study highlights the utility of several off-the-shelf tools for quantification of coral colony growth and erosion in 3D, a metric relevant to ecologist and managers. The novel methodology used greatly improves existing techniques for measuring coral colony growth and erosion. This is the first study to quantify the change in volume and surface area of table coral colonies through time using 3D models, and could be applied to other coral morphologies to quantify change in 3D coral structure caused by disturbances.

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SPATIAL DISTRIBUTION OF NOMINALLY HERBIVOROUS FISHES ACROSS A TEMPERATURE GRADIENT ON BRAZILIAN ROCKY REEFS (Abstract ID: 27962)

Herbivorous fishes are claimed to be an important functional group in tropical reef systems, however our knowledge of how the different functional groups respond to natural temperature gradients is still weak. Such info is clearly a baseline to understading how organisms will respond to possible warming events on the sea. We analysed patterns of herbivorous reef fishes density and biomass in a nearby (few kms) sites influenced (17oC) and not influenced (22oC) by upwelling currents in a subtropical rocky reef (23o S, 42o W). Assemblages of roving herbivores were consistently different between eastern, warmer, sheltered sites and western, colder, more wave-exposed sites. At eastern sites, detritivorous-herbivorous species dominated while omnivores had the highest biomass and were dominant at western sites. Macroalgivores did not show any trends related to location. These distributional patterns, at relatively small spatial scales of a few

kilometres, mirror large-scale latitudinal patterns observed for the studied species along the entire Brazilian coast, where cold water associated species are abundant on south-eastern rocky reefs (analogous to the western sites of this study), and tropical species are dominant on north-eastern coral reefs (analogous to the eastern sites). Species-level analyses demonstrated that depth was an important factor correlated with biomasses of Diplodus argenteus, Sparisoma axillare and Sparisoma tuiupiranga, probably due to resource availability and interspecific competition.
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CHANGING LOCAL ECOLOGICAL KNOWLEDGE IN THE SOLOMON ISLANDS: APPLYING AN INDEX OF TAXONOMIC DISTINCTNESS TO FOLK TAXONOMY (Abstract ID: 28325 | Poster ID: 592)

The Western Pacific region is rich in biological and cultural diversity. Local livelihoods are closely linked to marine ecosystems, as reflected in a range of customs, fishing methods, and local ecological knowledge (LEK) specific to the marine realm. A rich folk taxonomy enables communities highly dependent on living natural resources to harvest and manage them more efficiently, but also to detect and react to environmental change. A loss of this LEK threatens the adaptive capacity of communities, increasing their vulnerability to local and global environmental change. Ongoing economic and societal changes have eroded LEK worldwide, including the Western Pacific. However, research on folk taxonomy in connection with environmental change is mostly limited to assessing the richness of terminology. Focusing on the number of terms alone fails to account for additional embedded information on locally-known attributes, such as behavior or habitat. Yet, this information is vital to understand and detect ecological processes and react to changes. Indicators accounting for this added layer of information are also more likely to detect subtle changes in LEK than those focusing only on the type and number of different names. We applied an index of taxonomic distinctness to folk taxonomy in a number of Solomon Island coastal communities, examining differences in folk taxonomic knowledge between age and gender groups and at different distances to market, and assessing whether the index of taxonomic distinctness performed better at detecting changes than an index of taxonomic diversity.

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CORAL REEFS OF THE MAIN HAWAIIAN ISLANDS: A VANISHING RESOURCE? (Abstract ID: 28187 | Poster ID: 710)

The coral reefs of the Main Hawaiian Islands are a treasured resource for their cultural value, recreational use, food, coastal protection, and more. Seemingly robust and ubiquitous, they are in fact sparse, highly vulnerable, and currently imperiled. Reef accretion is severely limited by wave action, and in general modern reefs mostly consist of a thin live coral cover over ancestral reefs. Over-fishing, sediment pollution, and now climate change are threatening coral reef health and resiliency. The 2015 bleaching event was unprecedented in its severity and extent in Hawai`i, and more such events are projected to occur in coming decades. In view of the present and increasing stresses, reefs need effective, protective management to provide opportunities for survival. Specifically, nearshore regions of the four islands of Maui Nui contain nearly 15,000 acres of reefs having >50% live coral cover. Overall, these are the largest, most complex, and richest coral tracts within the Hawaiian Islands. Their extensive distribution, large size, connectivity, and natural wave sheltering make these reefs potentially resilient candidates for surviving regional-scale threats from climate change if other stresses are eliminated and they are properly managed. Currently, Hawaiian reefs are largely (<1%) unmanaged and unprotected, with few restrictions on fishing or pollution. These additional stressors make them highly vulnerable to bleaching induced by changing climate. Preliminary evidence indicates that widespread reef die-offs have triggered regime shifts that prevent reef recovery.

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EMPOWERING CORAL REEF MANAGERS TO ENHANCE RESOURCE MANAGEMENT THROUGH CONSERVATION ACTION PLANNING (Abstract ID: 30016)

Conservation Action Planning (CAP)/Open Standards for the Practice of Conservation (OS) is a powerful tool to guide conservation teams to develop focused strategies and measures of success. A worldwide community of trained conservation practitioners from over 60 organizations and agencies use this process to coach conservation teams to their vision of success at both local and regional scales. The five steps of CAP/OS provide project focus and team unity, even for diverse groups of stakeholders. In Hawaii, as part of a 6-year NOAA Coral Reef Conservation Program-The Nature Conservancy partnership, ten coral reef areas have benefited from convening teams of scientists, community members, conservation practitioners, fishers, landowners, government agency staff, and other stakeholders to strategically address conservation needs. Case studies illustrate the customized use of CAP/OS methods at these coral reef sites in Hawaii, and how the process was specifically designed to meet their needs and address priority threats such as land based pollution, unsustainable fishing, and climate change. A comparative analysis across the plans will illustrate the similarities and differences among the sites for target species and habitats, viability, priority threats, strategies, measures and key outcomes.

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ACCURACY AND PRECISION OF HABITAT STRUCTURAL COMPLEXITY METRICS DERIVED FROM UNDERWATER PHOTOGRAMMETRY (Abstract ID: 28126)

Photogrammetry together with application of structure from motion software is emerging as a leading technique to create three-dimensional (3D) models of corals and reefs from which biophysical properties of structural complexity can be quantified. It is essential to assess the accuracy and precision of photogrammetric measurements to support their application in research and monitoring. This study evaluated the precision (by repeated modeling) and accuracy (by comparison with laser reference models) of geometry and structural complexity metrics derived from photogrammetric 3D models of marine benthic habitat at two ecologically relevant spatial extents; individual coral colonies (of different morphologies) and patches of reef area of 100s of square metres. Surface rugosity measurements were generally precise across all morphologies and spatial extents with average differences in the geometry of replicate models of 1–6 mm for coral colonies and 25 mm for the reef area. Precision decreased with complexity of the coral morphology, with metrics for small massive corals being the most precise (1% coefficient of variation (CV) in surface rugosity) and metrics for bottlebrush corals being the least precise (10% CV in surface rugosity). The 3D geometry of coral models differed by only 1–3 mm from laser reference models however surface rugosity values for all morphs were underestimated by between 8% and 37%. This study provides important information on the accuracy and precision of models and metrics derived from off-the-shelf mapping systems which should allow for their targeted use by non-experts in computer vision within these contexts.

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CORAL CONNECTIVITY IN THE GREAT BARRIER REEF: NEW INSIGHTS INTO CURRENT AND FUTURE DISPERSAL PATTERNS (Abstract ID: 29792)

Dispersal patterns shape species' distribution, abundance and persistence, their potential for genetic drift and adaptation, and ultimately determine rates of recovery following disturbances. Because the larval mortality and competency dynamics of most marine organism is altered under warmer conditions, it is fundamental to understand how climate change will alter current connectivity patterns. Here we used an experimentally calibrated high resolution unstructured-mesh, depth-integrated hydrodynamic model (SLIM) to project current and climate change-mediated dispersal and connectivity patterns of corals in the Great Barrier Reef (GBR). We show that as oceans warm, coral connectivity will decrease. Specifically, the average dispersal distance from origin to destination reef and the number of incoming connections to each reef decrease. Interestingly, the proportion of larvae that find a suitable place to settle increases because more larvae will settle in their natal reef. We also show that broadcast spawning species with greater egg sizes, such as *Acropora* spp., will experience greater changes in dispersal patterns than species with smaller eggs. We identified the reefs which contribute the most to the larval supply in the GBR and the reefs which recovery rates will be more af-

fected by the change in connectivity patterns. Improved predictions of coral connectivity are essential to design networks of protected areas that contribute more effectively to the long-term sustainability and resilience of tropical reef ecosystems.

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LINKS BETWEEN COASTAL MARINE ECOSYSTEMS AND HUMAN WELLBEING IN JARDINES DE LA REINA NATIONAL PARK AND CAYOS DE ANA MARÍA FAUNA REFUGE, CUBA (Abstract ID: 28088 | Poster ID: 599)

This study shows the value of the economic benefits that Coastal Marine Ecosystems from Jardines de la Reina National Park and Cayos de Ana María Fauna Refuge provide to coastal communities. Values estimated for Jardines de la Reina National Park ($ 3.7 million of Cuban Pesos) are higher than the values of Cayos de Ana María Fauna Refuge (2.8 million of Cuban Pesos). In case of commercial fisheries, lobster is the main asset. It is important to continue the diversification of the fisheries activities such as mariculture. Besides, sustainable tourism, like diving should be increased moderately, giving priority for employment (such as dive masters, sailors, captains, cooks) to inhabitants of coastal communities. Sustainable economic activities increase income and conserve coastal and marine ecosystems at the same time, strengthening the perception of the link between human wellbeing and conservation of coastal and marine ecosystems.

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MOVEMENTS OF APEX PREDATORS IN A SMALL, ISOLATED MARINE PROTECTED AREA WITH IMPLICATIONS FOR RESOURCE MANAGEMENT. (Abstract ID: 29867 | Poster ID: 517)

Apex predators play a critical role in maintaining the balance of marine ecosystems and are an important component of Hawaii's recreational and commercial fisheries. In light of the increasing pressures on these populations across the main Hawaiian Islands, the study of apex predator movements in marine protected areas has become a research priority. To this aim, we used passive acoustic telemetry to investigate the spatial and temporal movement patterns of five apex predators: bluefin trevally (Caranx melampygus), giant trevally (Caranx ignobilis), green jobfish (Aprion virscens), whitetip reef sharks (Triaenodon obesus) and grey reef sharks (Carcharhinus amblyrhynchos) at the 31 ha Molokini Marine Life Conservation District (MLCD) off Maui, Hawaii. Our results indicate that the predator assemblage in the MLCD was dominated by teleost fishes during the day and sharks at night. Residency was variable across species, with bluefin trevally exhibiting the highest residency in the MLCD and green jobfish the lowest. Long distance movements between the Molokini MLCD and the other islands of the Maui Nui Complex were common for grey reef sharks, giant trevally, and green jobfish. These results indicate that despite its small size, the Molokini MLCD provides a high level of protection to resident species such as bluefin trevally. While the more mobile species (giant trevally, grey reef sharks and green jobfish) are protected while resident at the MLCD but open to the fishery during these large scale movements away from the reserve.

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THE IMPACT OF SPONGE FILTRATION ON THE CHEMICAL COMPOSITION OF CORAL REEF DISSOLVED ORGANIC MATTER (Abstract ID: 29994)

Sponges are efficient filter feeders, removing significant portions of particulates and dissolved organic matter (DOM) from the water column. Since sponges can process vast amount of water, they have the potential to shape the availability and composition of DOM where sponges are abundant. We applied untargeted and targeted metabolomics analytical techniques to seawater samples prior to entering the sponge (ambient reef water), samples released from the sponge (exhalent seawater), and to seawater collected just outside of the reef area (off reef seawater). Reef seawater samples were collected from two sponge species, *Ircinia campana*and *Spheciospongia vesparium*, on a near-shore hard bottom reef in the Florida Keys. Total organic carbon was not significantly different between samples, but was highest on average in the ambient seawater samples, followed by the exhalent samples, and lowest in the off reef samples. In contrast, metabolic profiles generated from the untargeted metabolomics analysis indicated that the concentration of many (n=430) metabolites was higher in the exhalent samples, while only some (n=52) metabolites were higher in the ambient reef samples. Finally, targeted metabolomics analysis revealed variation in the concentration of specific metabolites between seawater types. This work provides the first insight into the molecular-level impact that sponges have on DOM and provides a foundation for future experimental studies addressing the influence of sponge-derived DOM on chemical and ecological processes in coral reef ecosystems.

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INCREASED LOCAL RETENTION OF CORAL LARVAE DUE TO OCEAN WARMING MAY BE OFFSET BY ACIDIFICATION (Abstract ID: 27956)

According to climate change projections, coral reef recovery in the near future will take place in a warmer, more acidic ocean. The recovery potential of reef metapopulations relies on an adequate supply of larvae coupled with their capability to successfully recruit and establish themselves in the destination habitat. This study investigates the recruitment potential of the threatened Caribbean scleractinian coral *Orbicella faveolata* exposed to elevated temperature and ocean acidification (OA) conditions by quantifying larval survivorship and settlement from 2-14 days post-spawn. Although mortality was greater at higher temperatures, an earlier onset of settlement competency resulted in greater total number of settlers than at lower temperatures (78% increase at ambient CO2). However, this earlier onset was not observed under combined high temperature and OA conditions, indicating a delay in the development of competency as a result of high CO2. This delay in settlement due to OA was also observed at lower temperature but to a lesser extent. Thus, while the recruitment potential of *O. faveolata*may increase with increasing temperatures, this effect will be diminished if CO2 levels reach those forecast for the end of the century. Using coupled bio-physical connectivity models, we show how the changes in timing and magnitude of settlement can alter larval dispersal patterns affecting both the spatial distribution and abundance of potential recruits to Caribbean reefs and recovery potential as a whole.

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REEF FISH SPATIAL DISTRIBUTION AND BENTHIC HABITAT ASSOCIATIONS ON THE NORTHERN FLORIDA REEF TRACT (Abstract ID: 27957)

The Florida Reef Tract (FRT) extends from the tropical Caribbean up the southeast coast of Florida into a temperate environment where tropical reef assemblages diminish with increasing latitude. This study used data from a comprehensive fishery-independent survey to quantify reef fish spatial distribution along the FRT and define where the assemblage shifts from tropical to temperate. A total of 1,676 reef fish visual census surveys were conducted to assess the populations on randomly-selected sites of marine hardbottom habitats between the Miami River and St. Lucie inlet. Multivariate analyses were used to investigate differences in assemblages among sites. Depth (<12 m and 12-33 m), general habitat (reef or hardbottom), and slope (high or low) strata explained the dissimilarities between assemblages. A general trend of cold-tolerant temperate fish dominated the northern assemblages and more tropical species dominated further south. In shallow habitats the data clustered in three spatial regions: One south of Hillsboro inlet, one in Northern Palm Beach south of Lake Worth inlet, and one north of Lake Worth inlet. The assemblage in deep habitats mainly split in close proximity to the Bahamas Fracture Zone south of Lake Worth Inlet. Reef and hard-bottom assemblages did not differ significantly within regions but the reef habitat was significantly different than the hardbottom assemblages elsewhere. Substrate relief was significantly correlated with the differences in deep assemblages but did not appear to affect the shallow assemblages.

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PREDICTORS OF CORAL STRESS AND MORTALITY DURING DREDGING (Abstract ID: 29023)

Over the last decade there has been a series of large scale dredging programs off Australia's North West Coast. These projects were large by global standards, in terms of the dredge volumes processed as well as the scale and quantity of associated water quality and biological data that were collected. The data collected during these programs provides an excellent opportunity to explore: what happens to water quality during dredging; how this impacts upon coral health; the spatial and temporal scale of dredging impacts; and may ultimately allow the development of water quality threshold values that can be used to manage other dredging programs in the future. Characterising water quality using turbidity and light data collected over minute time frames yet spanning time series of several years can be highly complex, and can differ greatly across temporal scales (hours versus month) and with the statistical metrics used (mean verus median). Here we explore a range of water quality metrics and examine how well these can predict coral stress and mortality.

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DOES CHLOROPHYLL-A TURN UP THE VOLUME? EXPLORING THE RELATIONSHIP BETWEEN OCEANOGRAPHIC FACTORS AND CORAL REEF SOUNDSCAPES. (Abstract ID: 29623)

Remote coral reefs offer unique opportunities to explore how biological activities around coral reefs are influenced by oceanographic variables. Little is known about how oceanographic properties like chlorophyll-a, sea surface temperature, and wave energy flux influence acoustic biological signals. In this study, long-term passive acoustic monitoring methods were used to examine the soundscapes of three remote coral reef locations in the Pacific Ocean. Acoustic signals were separated into different frequency bands and the relationships between coral reef soundscapes and oceanographic variables were explored through generalized linear models and generalized additive models. Geophony is mostly observed in the lower octave bands, while biophony is reflected in the higher octave bands. Snapping shrimp are the dominant contributors to tropical and subtropical coral reef biophony. While our results confirmed the positive correlation between snapping shrimp signals and temperature, a negative relationship with chlorophyll-a was found; as chlorophyll-a increases, the overall soundscape decreases. The site with the highest levels of chl-a had the loudest soundscape, possibly suggesting that high nutrient coral reefs support increased snapping shrimp abundance and/or higher levels of acoustic activity. This study is an example of how an interdisciplinary approach to exploring relationships between soundscapes and oceanographic variables appears to be an effective method of further understanding remote coral reef environments.

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FUNCTIONAL ASPECTS OF THE JELLYFISH CASSIOPEIA XAMACHANA - SYMBIODINIUM SYMBIOSES (Abstract ID: 28817 | Poster ID: 122)

Jellyfish of the genus Cassiopea rely on the establishment of a symbiosis with the dinoflagellate Symbiodinium in the asexual polyp portion of their life cycle. The polyp, or "scyphistomae," then strobilates a medusa (jellyfish). Many species of Symbiodinium are able to infect scyphistomae and induce strobilation, but in nature adult Cassiopea xamachana harbor Symbiodinium microadriaticum (= A1). While polyps may be found with various symbiont species, their displacement by S. microadriaticum occurs early during the ephyra stage. To examine functional differences among resident symbionts, net photosynthesis and respiration were measured on ephyra containing either Symbiodinium microadriaticum (A1), B1, B3, S. goreaui (C1), C2, or S. trenchii (D1a) at 26 and 30oC. While all Symbiodinium spp. photosynthesized at normal high rates when exposed to 26oC, only S. microadriaticum and S. trenchii maintained these rates at 30oC. All other species of Symbiodinium exhibited significant signs of photo-damage. These observations offer a physiological basis for selection of S. microadriaticum by C. xamachana. Larvae settle on the shady-side of mangrove leaves, and the scyphistomae strobilate medusae when temperatures are warm enough and they have acquired Symbiodinium. The medusae move to more sunny areas in mangrove habitats. However, some Symbiodinium are sensitive to the high temperatures/light that occurs in this habitat during the summer. Symbiodinium microadriaticum survives and has a high photosynthetic rate in the environment that Cassiopea xamachana thrives in today.

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SO YOU'VE GOT SOME TECHNOLOGY, NOW WHAT? (Abstract ID: 29938)

Currently, a gap exists between the potential that technology can play in improving conservation management—especially increasing fisheries-relevant data collection in artisanal fisheries—and the reality of implementing that technology effectively on the ground. There are several drivers behind this short-coming, including: 1) efforts to promote technology uptake in emerging markets often focus solely on usability when, in reality, usability is only one of several critical factors that determine whether or not a specific technology is appropriate for a particular community and purpose; and 2) a disconnect between improved data collection on the water and robust data storage, sharing, and analytical capacity within fisheries management bodies and seafood supply chains. With the recent growth in the number of initiatives looking to deploy new on-the-water technologies for conservation gains, closing this gap becomes increasingly important. Through dynamic storytelling, this talk will share the experiences and insights around designing and implementing mobile applications for improved fisheries data collection and traceability in artisanal fisheries. Examples of both success and failure provide lessons for future efforts to promote technology uptake in similar fisheries around the world.
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PHYLOGENETIC PERSPECTIVES ON THE EVOLUTION OF REEF FISH FUNCTIONAL DIVERSITY (Abstract ID: 27992)

Functional traits have been fundamental to the evolution and diversification of entire fish lineages on coral reefs. Yet their relationship with the processes promoting speciation, extinction, and the filtering of local species pools remains unclear. Using published and new data, we mapped functional traits on to phylogenetic trees to infer evolutionary patterns that have led to the current functional diversity of fishes on coral reefs. Diet and feeding mode were reconstructed on time-calibrated phylogenies for several reef fish families. We found examples of independent transitions to planktivory across different reef fish families that may represent cases in which ecological opportunity for the exploitation of different resources drives speciation and adaptation. The evolution of body sizes in the family Labridae shows no relationship with lineage age, with both large and small body sizes appearing multiple times within clades of mid-sized fishes. The reconstruction of range size revealed that ranges are constrained by the geography and size of ocean basins. Also, there were many cases of disparate range sizes among sister species. The diversity and evolution of traits within lineages is influenced by trait-environment interactions as well as by species and trait-trait interactions, where the presence of a given trait may trigger the development of related traits or behaviors. Our efforts to assess the evolution of functional diversity across reef fish clades add to the burgeoning research focusing on the evolutionary and ecological roles of functional traits.
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DIMETHYL SULFIDE (DMS) IN MARINE ECOSYSTEMS. (Abstract ID: 27775 | Poster ID: 365)

DMS is a biogenic sulfur gas that is particularly abundant in marine ecosystems and that may influence climate regulation by contributing to the formation of clouds when oxidised into sulfate campounds in the atmosphere. Today, climate change is altering marine ecosystems, with these changes being expected to affect DMS production and emissions in the future. Changes in marine DMS production has been observed in a diversity of ecosystems such as coral reefs, upwelling ocean, mangrove, saltmarsh and seagrass environments. However, the extend and consequences of these changes still remain to be evaluated in order to make appropriate predictions for the fate of DMS in a changing ocean. Here, we provide a brief review of the prospective changes to DMS production across the various marine ecosystems.

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DELIMITING REEF SPECIES USING HETEROZYGOSITY (Abstract ID: 29816)

Molecular taxonomists commonly turn a blind eye to heterozygosity by discarding loci that display intra-individual heterogeneity, by excluding heterozygotes from their analyses and/or by retaining only one of their allelic sequences. Indeed, the chromatograms of heterozygotes were long considered impossible to resolve without cloning since they contain double peaks. However, bioinformatic tools such as my programs Champuru and SeqPHASE are now available to unravel mixed chromatograms. Once the haplotypes of a collection of individuals have been determined accurately using Sanger or next-generation sequencing, knowing which alleles co-occur in heterozygotes makes it possible to delineate species in an accurate and sensitive fashion. Here I present a graphical method that relies on haplotype webs (in short, haplowebs) to delineate reef species. Haplowebs are trees or networks of haplotypes on which curves are added to connect haplotypes found co-occurring in heterozygous individuals, thereby providing an easy, intuitive way to delineate groups of individuals sharing a common gene pool. In contrast to other popular approaches such as ABGD and GMYC that are geared towards species-rich datasets, haplowebs are well-suited to detect species boundaries in species-poor systems, e.g. when the hypothesis that all the individuals sampled are conspecific cannot be rejected beforehand. Haplowebs do not assume species monophyly nor the existence of a barcoding gap. Besides, haplowebs can be used to detect introgression and hybridization.
http://ebe.ulb.ac.be/ebe/Flot.html

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MANAGEMENT RELEVANT INTERPRETATION OF REEF MONITORING DATA (Abstract ID: 29714)

Coral reef monitoring is expensive and time consuming, but the data collected is only infrequently used to guide management actions. One reason for this is that managers and conservation practitioners lack a simple guide for interpreting and understanding the ecological meaning of the monitoring data. Here we develop such a guide, using a medical "diagnosis" and "prognosis" approach. Based on evidence from the published literature we provide a guide to interpreting the temporal trends in the main coral reef monitoring attributes recorded by the seven largest coral reef monitoring programmes. Using select indicators from this guide, we propose a simple decision process for diagnosing the main stressor(s) that have impacted a reef. Finally, we integrate the diagnosis with further indicators to provide a prognosis for a reef; a measure of the recovery potential of the reef. Although previous studies have suggested the use of the medical examination approach for coral reefs, this is the first study to develop this method using commonly collected, or easy to collect, reef monitoring data. Our work offers reef managers a guide to what variables to focus monitoring on, and simple methods for interpreting monitoring data to guide management decisions.

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EXTENSIVE PHENOTYPIC VARIATION IN CARIBBEAN ACROPORID HYBRIDS IS LIKELY A MECHANISM FOR ADAPTATION TO CHANGING ENVIRONMENTS (Abstract ID: 29469)

The merging of two genomes through hybridization produces a unique combination of traits and phenotypic variation in the hybrids. This phenotypic variation may promote hybrid adaptation to habitats not accessible to the parent species. While hybridization is common in corals, evidence for adaptation to new habitats due to morphological innovation in coral hybrids is missing. In the past, hybridization between Caribbean Acropora palmata (elkhorn) and A. cervicornis (staghorn) corals was rare and restricted to the F1 generation. New genetic data indicates that hybrids are now mating with each other and are capable of mating with A. palmata and A. cervicornis. In parallel, a variety of intermediate morphologies to the arborescent staghorn and elkhorn shaped parental species are now observed. Here, we conducted morphometric analyses using high-resolution 3D scans and scanning electron microscopy on Caribbean acroporid colonies representing the continuum of phenotypes between A. cervicornis and A. palmata and correlated the data with the genetic origin of the hybrid (i.e. F1, F2 or backcross). These data together with recent field observations of higher disease resistance, higher thermal tolerance, higher hybrid abundance, and hybrid habitat expansion suggests that the hybrids' ecological role and evolutionary potential is changing. Thus, coral hybrids are a possible and probable mechanism for coral adaptation to changing environmental conditions.

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SIZE-MATURITY INDICATORS IN QUEEN CONCH OF PORT HONDURAS MARINE RESERVE, BELIZE; STRENGTHENING MANAGEMENT FOR IMPROVED FISHERIES SUSTAINABILITY (Abstract ID: 28736)

Queen conch (*Lobatus gigas*) is an important food source and economically important export product in Belize. Overfished in many parts of the Caribbean, international trade of *L. gigas* is regulated by CITES. This study compares relationships between gonad development and shell length, lip thickness (LT), lip width, meat weight, market-clean weight and operculum dimensions to determine the most reliable proxy indicator(s) of maturity in*L. gigas* specific to Port Honduras Marine Reserve (PHMR), south Belize. Until recently, PHMR enjoyed a relatively stable population, regulated by a 17.8cm national shell length limit or 85g market-clean meat weight, a 3-month closed season, and full protection in Replenishment Zones. However, TIDE fisheries-independent surveys indicate population decline with diminished reproduction since 2013. Fisheries-dependent catch surveys reveal the proportion of catch with LT <9mm (minimum maturity threshold in other studies) increased from 30% in 2009 to 90% in 2012. Other studies show LT is a more reliable indicator of maturity, but that maturity relationships vary on local and regional levels and therefore need to be determined locally. Phase 1 (late open season) LT: maturity relationships were stronger for males than females, with >80% probability that males >25mm LT are or have been spawning capable. Phase 2 results (closed reproductive season) are expected to yield stronger relationships for females. Recommendations are made for size limit revisions to achieve long-term sustainability of *L. gigas* in PHMR while meeting economic needs of fishers. http://www.tidebelize.org/project/marine

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WHY ARE SOME EASTERN TROPICAL PACIFIC REEFS SO RESILIENT TO ENSO? BIOASSAYS REVEAL INCREASED HERBIVORY AND NUTRIENT LIMITATION DURING ENSO (Abstract ID: 28877)

Long term studies of reefs in the Eastern Tropical Pacific before, during and after 2 major ENSOs (82-83, 97-98) revealed that some reefs showed remarkable resilience through rapid recovery of coral cover. We hypothesized that increased herbivory and nutrient limitation during ENSO may limit algal proliferation during warming events and therefore facilitate coral recovery. We conducted short-term bioassays using dominant species of macroalgae to compare the relative strength of these top down and bottom up forces prior to and during ENSO-associated warming in 2 sites in Panama and 1 in the northern Galapagos. At both sites in Panama herbivory rates increased ~ 60% during warming conditions. While nutrient limitation was strong prior to warming in both sites, during warming algae was only able to maintain positive growth when nutrient limitation was reduced by added nutrients, even while protected from herbivores. In the Galapagos, herbivory was extremely strong regardless of warming. In contrast, nutrient limitation varied greatly across sampling times. Prior to warming, algal growth in ambient nutrients was vigorous (40-50% increase in 3 days) and increased up to 90% with added nutrients; however, even mild warming conditions in the Galapagos caused up to 75% loss of algal biomass, even while protected from herbivores, regardless of experimental nutrient addition. If intensification of the strength of these processes limiting algal proliferation is maintained, this may facilitate coral recovery. However, it is possible La Nina may reverse this process and facilitate algae.

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THE MACROECOLOGY OF AGONISTIC INTERACTIONS IN REEF FISHES (Abstract ID: 29842)

Biotic interactions may influence species coexistence and act as an important selective pressure for evolution. In coral reefs, interspecific competition can alter spatial distribution of reef fishes and is mainly influenced by variation in habitat quality and species density. Only a few studies have addressed this issue over large spatial scales. Therefore we aimed to investigate the relationship between regional richness and the structure of agonistic interactions of reef fishes. Our dataset comprised seven tropical reefs across four biogeographic provinces (Brazil, Caribbean, Central Pacific and the Coral Triangle). Species richness and agonistic interactions data were collected through remote videos of shallow sheltered reefs, each sample consisting of a 2m 2 area during 10 min. We observed a higher species accumulation in regionally richer localities and a positive relationship between local and regional richness. For interactive species, we observed the same trend in species accumulation, but not the local and regional relationship. This pattern can be explained by the increasing species turnover towards richer regions. Moreover, the complexity of agonistic networks increased according to the regional richness gradient. Damselfishes, surgeonfishes and labrids mainly structured the networks in all regions and territorial herbivores performed a central role in all local communities. Our study identified key functional groups in agonistic networks and highlighted the increase in diversity of interspecific interactions towards increasing regional species richness. http://www.lbmm.ufsc.br

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COMMUNITY-BASED SOCIAL MARKETING – THE CONSERVATION TOOL MOST OF US AREN'T USING BUT PROBABLY SHOULD BE (Abstract ID: 29020)

Community-Based Social Marketing (CBSM) aims to influence behavior in support of conservation objectives through a well-defined strategic process that is informed by social psychology and incorporates quantitative research and evaluation methods. CBSM is underutilized and often misunderstood, but has great potential to foster sustain-

able behavior and effect change. Several case studies and their accompanying media and communication strategies will be presented and critically examined, including the West Maui Kumuwai Campaign, an ongoing effort focused on reducing the land-based pollution that impacts coral reefs. ----- *I'm hoping to further edit this abstract later on if possible, when I don't have pneumonia...

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INCONSISTENCIES BETWEEN TRADITIONAL AND NEW MONITORING TECHNIQUES FOR ASSESSING CORAL REEF RESILIENCE: AN EXAMPLE FROM FIJIAN LOCALLY MANAGED MARINE AREAS (Abstract ID: 29238)

Considering increasingly stressful conditions for coral reefs, it is critical to evaluate the effectiveness of varying management tools. In this context, it is essential to develop tools which identify ecosystem trajectories and provide early warnings of reef degradation. To achieve this, surveys should look beyond standard monitoring parameters (i.e. herbivore biomass, benthic cover), by quantifying system processes (i.e. herbivore grazing, algal turnover, coral recruitment), and complementing status parameters (i.e. turf algae length which could affect coral recruitment, state of coral-algal interactions that indicate competitiveness, damselfish movements which influence algal dynamics). A comprehensive review allowed us to develop a suite of informative parameters that were applied in Fiji, where locally managed marine areas (LMMAs) are well-established and allow an evaluation of community-based management. Surveys covered two depths inside and outside of three enforced inshore LMMAs. Location and water quality analyses confirmed that differences between paired reefs were driven by management. Tentative results highlight a decoupling between the findings of traditional monitoring and our parameters. For example, although benthic composition and fish biomass were similar inside and outside of LMMAs, the former displayed significantly shorter turf length and higher coral recruitment, implying that LMMAs can indeed enhance reef resilience. We propose a combination of process and status parameters that should be considered to improve evaluation of management effectiveness.

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ISLAND GROWTH DURING RISING SEA LEVEL: JEH ISLAND, REPUBLIC OF THE MARSHALL ISLANDS (Abstract ID: 29552 | Poster ID: 401)

Low-lying reef islands are coral reef associated deposits of biogenic sediment considered highly vulnerable to the effects of sea level rise (SLR). One of the most frequently discussed impacts of continued SLR is the destabilisation and 'washing away' of reef islands. However, recent studies from throughout the Pacific have shown that reef islands have been predominantly stable or have accreted since the mid-20th century, a period coincident with accelerating rates of SLR. In order for shorelines to accrete and drive island growth there must be a supply and delivery of sediment to the island. The sediment contributing to island growth can either be generated under contemporary conditions, or relic sediments which have previously been stored within the reef framework, or within sub- and inter-tidal or island deposits. Establishing whether islands can accumulate modern sediment is critical to understanding future trajectories of reef island change. This study focusses on the island of Jeh on Ailinglaplap Atoll, where aerial photos from 1943 and satellite imagery from 2010 reveal pronounced island change and growth. Using radiocarbon dating of recently deposited sections of Jeh Island we are able to determine that island growth is on-going and largely driven by the accumulation of modern sediment. The growth of the island has occurred coincident with locally increasing sea level and these results highlight the importance of sediment supply in the response of islands to further SLR.

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A COMPREHENSIVE MOLECULAR AND MORPHOLOGICAL STUDY OF CERIANTHARIA (ANTHOZOA,CNIDARIA) ACROSS SEAS (Abstract ID: 27771)

Cerianthids or tube-dwelling anemones (order Ceriantharia) are cryptic, solitary polyps that live buried in soft sediments in self-constructed tubes, which are made of a fibrous material made from secreted mucus and a kind of cnidocyst-like cells, known as ptychocysts, which are unique to this order. Recently cerianthids came to the attention of the scientific community because of their resilience and dominance in anthropogenic disturbed costal areas including coral reefs. To date little is know about cerianthid phylogeny and geographical distribution. Here we present a phylogenetic and morphological characterization of cerianthids collected at several locations: Mediterranean, Baltic Sea, Celebes Sea, Red Sea and Pacific Ocean. During this effort we identify few new species and shed lights on their, until now confusing, phylogeny. Furthermore we extensively characterized their elegant cnidocyst macromolecular structure at an unprecedented resolution. This work and the data presented here will help to better understand this order of marine invertebrates that are likely to become an important assessors of ecosystems perturbance.

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LARVAL REEF FISH RESPOND TO DIMETHYL SULFIDE AND HOME TO ITS SOURCE (Abstract ID: 28203)

Transport of coral reef fish larvae is driven by advection in ocean currents and larval swimming. For swimming to be advantageous, larvae must use external stimuli as guides. A potential stimulus is "odor" emanating from coral reefs, which signals the upstream location of desirable habitat. However, specific chemicals and mechanisms for plume tracking have not yet been identified. Dimethyl sulfide (DMS) is produced in large quantities at coral reefs and may be an important cue. In this study, a choice-chamber (shuttle box) was used to assess preference of reef fish larvae for water with DMS and potential changes in swimming behavior. Video tracking of larval movement was used to compare swimming patterns in control and DMS seawater. We found a common response to the presence of DMS across taxa – a preference for water with DMS and a significant increase in turning frequency - reflecting a switch to "search behavior". Detailed patterns of movement when encountering a dyed DMS plume were monitored in a large flume tank to assess whether and how larvae were able to locate the source of DMS. Larvae quickly located the source of odorous plume injections in the flume but did not respond to plumes of non-odorous dye in seawater. Affinity for and swimming response to relevant concentrations of DMS allows a fish larva to locate its source and would enhance its ability to find settlement sites. Moreover, it may help them locate high concentrations of prey accumulating in fronts, eddies, and thin layers, where DMS is also produced.

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PARSING METAGENOMIC LOCI FROM THE CORAL HOLOBIONT: NEW INSIGHT INTO UNRESOLVED SPECIES COMPLEXES IN PORITES, POCILLOPORA, AND MONTIPORA. (Abstract ID: 28090)

Genetic studies of non-model organisms have been restricted to a few markers that have limited resolution and utility, resulting in gaps in the understanding of the ecology, evolution, biodiversity, biogeography, extinction risk, and adaptive potential of organisms such as reef building corals. Next Generation Sequencing approaches such as RAD sequencing have shown promise for resolving both very recent and ancient divergence; however, the absence of reference sequences creates major challenges for the identification and comparison of loci particularly for metagenomic datasets such as the coral holobiont. Here, we discuss several strategies for identifying and parsing loci from components of the coral holobiont, including reconstruction of complete or nearly complete mitochondrial genome, the ribosomal array, histones and a diverse set of coral protein coding genes. The resulting data provides unprecedented resolution into unresolved species complexes. We present several examples of the application of these methods towards Porites, Pocillopora, and Montipora. We find surprising mitochondrial-nuclear discordance in Porites consistent with hybridization, supported by STRUCTURE analysis from thousands of SNPs. In contrast, Pocillopora and Montipora have strong concordance among nuclear and mtDNA datasets, allowing us to examine within species variability for these genera, including M. dilatata, one of the rarest known corals. The ability to extract and compare known loci from these metagenomic datasets will further improve as more reference sequences become available, providing additional insights into the ecology, evolution, and conservation of reef building corals.
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GROWTH AND LONGEVITY OF ICONIC REEF FISHES IN VERDE ISLAND PASSAGE, PHILIPPINES (Abstract ID: 28588 | Poster ID: 260)

Scarus niger and Acanthurus pyroferus are important iconic grazers in the Northern part of the Verde Island Passage, Philippines. Hence, important life history characteristics must be established for purposes of managing their population. The study focuses on the age and size relationship of these reef fish species using the von Bertalanffy growth function. Fish sample size for S. niger (n=146) ranged from 143.6 to 268.2 mm with age estimates ranging from 3 to 12 years. For the collected A. pyroferus samples (n=38), standard length ranged from 119.5 to 159.5 mm with age estimated between 5 to 9 years. Morphometric characters of otoliths (i.e., size and shape) were also examined to determine any relationships that would help verify the validity of the age estimates. The results showed that the size (SL) of both species had strong and linear relationship with their wet body weight (g) establishing an isometric growth pattern (b≈3.0) for both species. Furthermore, linearity between otolith width (mm) and otolith weight (mg) was observed in females only and strong linear relationship between otolith index, fish size (SL) and body weight (g) for both species. In general samples collected for both species were at their rapid growth stage and reflected strong linear relationship between their age and body size. The initial batch of samples collected was at their mid- to large body size range. Thus, collection in the next two months will now target smaller and much younger fish to complete the growth history curve for both species.
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A COMPARISON OF SYMBIOTIC DINOFLAGELLATE (SYMBIODINIUM) COMMUNITIES IN HEALTHY SIDERASTREA SIDEREA CORALS AND THOSE AFFECTED BY DARK SPOT SYNDROME (Abstract ID: 28909 | Poster ID: 160)

Dark Spot Syndrome (DSS) is an indicator disease prevalent in coral reefs throughout the Caribbean. Often DSS is non-fatal though it can lead to more aggressive diseases such as Black Band Disease (BB) and Yellow Band Disease (YB). Although ubiquitous, little is known about the cause and spread of DSS. This study aims to further characterize the symbiotic dinoflagellate community and potential factors leading to DSS in Siderastrea siderea corals by microbial comparison of healthy and DSS affected corals from one time point. To study this syndrome, Symbiodinium communities were collected from coral mucus samples and were identified using high-throughput techniques to elucidate potential factors of disease progression. In both healthy and DSS affected samples, no significant differences were found in the relative abundance of mucus associated Symbiodinium communities, implicating that DSS is a multi-faceted syndrome that does not directly impact the photosynthetic Symbiodinium of afflicted corals.

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HAWAII'S ENVIRONMENTAL COURT - BRIDGING SCIENCE TO POLICY THROUGH IMPROVED ADJUDICATION OF RESOURCE VIOLATIONS (Abstract ID: 28244)

This paper will examine Hawaii's Environmental Court, established in 2014. Although environmental courts exist in other states, Hawaii's Environmental Court is the first in the nation with a strong emphasis on natural resource management and enforcement. The Court was established largely in response to the State's difficulties enforcing and adjudicating its laws pertaining to aquatic and terrestrial resources. In addition to other challenges, the State Department of Land and Natural Resources was having difficulty achieving positive outcomes for cases involving legally or scientifically nuanced violations. In response to this problem, the Hawaii State Legislature established the Environmental Court. The legislation provided the Court with exclusive jurisdiction over nearly all of the state's natural resource statutes. Under the Court's structure, the judiciary trains designated judges to hear resource violation cases. Many of the training materials are developed in collaboration with scientists and resource managers working in corresponding subject matter areas for the State of Hawaii. This results in enhanced judicial awareness about the impact of resource violations on ecosystems and the communities that reside therein. Establishment of the Court represents a meaningful and collaborative effort by policymakers, resource managers and members of the judiciary to ensure that resource violations receive the attention they deserve by persons with specialized knowledge regarding environmental issues.

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CONSERVING HAWAIIAN COMMERCIAL HARBOR CORAL REEF RESOURCES IN A S.M.A.R.T. WORLD BY KEVIN B. FOSTER (Abstract ID: 28913)

Large plate corals, seagrass meadows, green sea turtles, marine plants, non-coral invertebrates, and reef fish make their home in Hawaiian commercial harbors. The U.S. Army Corps of Engineers (USACE) is responsible for maintaining or expanding federal limits within commercial harbors; conducting maintenance or new dredging to meet safety considerations, or expanding the turning basins to accommodate larger cruise ships and cargo vessels. The USACE coordinates project planning activities with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and State of Hawaii's Division of Aquatic Resources. Recent surveys document extensive resources that have adapted to commercial harbors despite altered water quality conditions, such as exposure to fresh water, sediments and pollution. These hardy individuals may present clues towards the future survival of coral reefs in a changing climate. The USACE's adoption of the SMART planning process, nationally, is intended to streamline feasibility studies and expedite project completion, potentially at the expense of adequate mitigation for Hawaiian coral reef resources. The USACE's Honolulu District Civil Works Division has the lead for implementing the SMART process locally and therefore, a new paradigm should be developed and standardized when coordinating the evaluation of project alternatives and recommendations for mitigating project impacts to coral resources with state and federal resource agencies.

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OCEAN ACIDIFICATION CAUSES STRUCTURAL DEFORMITIES IN JUVENILE CORAL SKELETONS (Abstract ID: 28010)

Rising atmospheric CO2 is causing the oceans to both warm and acidify, which could reduce calcification rates of corals globally. Successful coral recruitment and high rates of juvenile calcification are critical to the replenishment and ultimate viability of coral reef ecosystems. While elevated pCO2 has been shown to reduce the skeletal weight of coral recruits, the structural changes caused by acidification during initial skeletal deposition are poorly known. Here we show, using high resolution 3-dimensional X-ray microscopy, that ocean acidification (pCO2 ~ 900 uatm, pH ~7.7) causes not only reduced overall mineral deposition, but also a deformed and porous skeletal structure in newly settled coral recruits. In contrast, elevated temperature (+3°C) had little effect on skeletal formation except to partially mitigate the effects of elevated pCO2. The striking structural deformities we observed show that new recruits are at significant risk, being unable to effectively build their skeletons in the pCO2 conditions predicted to occur for ocean surface water under a 'business-as-usual' emissions scenario (RCP 8.5) by the year 2100.

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NATURAL VS. ANTHROPOGENIC SEDIMENTATION: DOES REDUCING A LOCAL STRESSOR INCREASE CORAL RESILIENCE TO CLIMATE CHANGE? (Abstract ID: 28236)

Corals face worldwide population declines due to global climate change and local anthropogenic impacts. Global climate change effects are hard to tackle but recent studies show some coral species can better handle climate change stress when provided with additional energy resources. The local stress that most undermines energy acquisition is sedimentation because it impedes coral feeding and their ability to photosynthesize. To investigate if reducing local sedimentation will enable corals to better endure global climate change, we quantitatively assessed the synergistic effects of increased temperature, sediment concentration, and sediment composition on the survival and growth of juvenile *Porites astreoides*. We used sediment from a reef and a boat basin to mimic natural sediment (more coarse) and anthropogenic sediment (finer grain sizes, more common in dredging operations). The most detrimental effects were observed with anthropogenic sediment. We found that corals' capacity to deal with higher temperatures is improved when anthropogenic sedimentation is maintained at minimal levels. Our study suggests that a reduction of allowable NTU's from 29 to 7 near coral reefs should facilitate coral juvenile survival under higher temperatures. Additionally, dredging operations should be conducted in Winter to minimize synergistic effects of temperature and sedimentation.

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STRENGTHENING SCIENCE AND CAPACITY FOR CORAL REEF CONSERVATION (Abstract ID: 29898)

Effective coral reef conservation relies on ecological and social monitoring and evaluation to inform adaptive management. With potentially high costs of monitoring and most coral reefs in developing countries, strategies to ensure a good return on investment are critical. These include investing in aspects of monitoring beyond data collection (e.g., study design, data management, communication); and strengthening local scientific capacity for this full cycle of monitoring. We highlight initiatives in the Coral Triangle and beyond that aim to increase scientific value of monitoring without significantly increasing costs. 1) In the Bird's Head Seascape of Indonesia, long-term investments were made to build capacity of local staff to manage, analyze, interpret and communicate data. 2) In five countries with high marine biodiversity and community dependency on fisheries (Belize, Brazil, Mozambique, Indonesia, and the Philippines), a monitoring program was designed to evaluate the outcomes of TURF-reserves (territorial use rights for fisheries and no-take reserves) coupled with community engagement. Both efforts seek to support site-level adaptive management as well as multi-scale analyses to inform marine conservation policy, and both required increased attention to study design and data management. This has spurred innovative tools to enhance collaborative analysis and communication, offering tremendous opportunity for advancing science and laying the foundation for scaling effective and efficient approaches to place-based marine conservation and fisheries management.

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REGIONAL-SCALE OCEANOGRAPHY INFLUENCES BENTHIC CORAL REEF COMMUNITY STRUCTURE IN THE REMOTE CENTRAL PACIFIC (Abstract ID: 29881)

Increased inorganic nutrient concentrations are often associated with changes in community structure on coral reefs, particularly shifts from coral to macroalgal-dominated states. Yet experimental manipulations of nutrients have often been conducted over limited temporal scales and do not examine ecosystem-scale responses. Using five uninhabited islands that span a natural gradient of nutrient availability in the remote central Pacific, we examined how distinct nutrient regimes relate to the structure of benthic coral reef communities in the absence of local human impacts. Specifically, we tested how this natural gradient influenced the relative abundance of key benthic taxa and the proportion of autotrophy to heterotrophy in common coral species across depth (5-30 m). We hypothesized that corals on more nutrient-limited reefs would exhibit higher dependence on autotrophy at shallower depths while corals on more nutrient-replete reefs would exploit heterotrophic resources at all depths. Ambient inorganic nitrogen concentrations ranged from 0.46-4.45 μ mol · $L^{-1}$and we observed diverse patterns in coral and algal cover across this gradient. Coral cover varied from 5-87% and 0-78% at 5 and 30 m, respectively. Heterotrophy in corals correlated positively with nutrient availability and did not exhibit clear depth zonation at more nutrient-rich islands. These results suggest that natural nutrient delivery can have dynamic impacts on benthic coral reef communities that are more complicated than direct shifts towards macroalgal-dominance.

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DIFFERENCE IN SUBSTRATE COVERAGE BETWEEN A DISTURBED AND AN UNDISTURBED CORAL REEF SITE AND THE IMPLICATIONS FOR FISHERIES MANAGEMENT (Abstract ID: 28854 | Poster ID: 410)

This study was conducted in the Dampier Straight, Raja Ampat, Indonesia, one of the most biodiverse coral reef regions in the world. Two sites were chosen, a disturbed reef that was in very close proximity to a fish farm, as well as the presence of boating detritus and an undisturbed reef site that had no such anthropogenic influences present. Comparison of visual differences in substrate coverage were examined at each reef. Six, 20 meter transects were completed at each site. A photograph was taken every two meters on the transect and were later examined to determine percent cover. Four different categories were created for substrates to determine percent cover: hard coral, soft coral, algae and other/ unknown, such as sand or live rock. Prominent species of coral and algae were also noted for each of the photos. After analyzing the data using an independent samples t-Test, results showed significantly more algae cover at the disturbed site compared to the undisturbed site. Significantly more soft coral and unknown coverage was measured in the undisturbed site compared to the disturbed site. There was no significant difference between sites in terms of hard coral coverage. Understanding the conditions necessary for the support of diverse reef ecosystems, and the possible threats that could cause them to deteriorate is critical for the effective management of fisheries and development of marine sanctuaries.

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DISTANCE DECAY IN SIMILARITY OF CORAL REEF COMMUNITIES (Abstract ID: 29073)

Distance decay of community similarity is a fundamental concept in ecology, where near things are more related than distant things, and was once known as the "First Law of Geography". Nevertheless, despite the fundamental importance of distance decay for understanding the processes that structure assemblages of species, almost all our understanding of this phenomenon comes from studies of tropical plant communities. In this study we quantify distance decay in a marine invertebrate community by comparing scleractinian coral assemblages along an 1100km latitudinal gradient on the Great Barrier Reef. We also compare the rates of distance decay between three distinct habitats; outer shelf, lagoonal and mid-shelf reefs. Despite the general view that marine systems are more 'open' than terrestrial systems, we find overall distance decay to be as strong in marine benthic assemblages as in terrestrial assemblages. We use the novel method of beta-diversity partitioning to look further into the processes that cause this distance decay, and find that differences in taxonomic β–diversity between reefs are governed by species replacements rather than a net change in diversity (species loss or gain). Furthermore, the replacement of species appears to be by species from within the same functional group, as no distance decay of functional β–diversity was found. These analyses indicate that species replacement is not a random process, and our results therefore provide insight into the environmental and biological processes that structure coral reef assemblages.

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PUTTING MARINE POLICY INTO PRACTICE: THE USE OF POLICY IN MARINE PROTECTED AREA MANAGEMENT (Abstract ID: 27869)

An ever-growing range of environmental, legal and policy initiatives, such as international agreements, laws and conventions aim to protect biodiversity, and improve management of human activities which impact on marine environments. Along with policies at the international level, complexity is added by a range of national and state policies. For effective management to occur, the intent and goals of these policies at various jurisdictional levels need to be harmonised and integrated. Fragmented sector-based marine management is likely to be a major contributor to the decline in health of oceans, where problems created by a patchwork of policy constrain achievement of management goals. We analyse how the management of Australian marine protected areas (MPAs) is undertaken when applying a range of policy, agreements and legislation, and how the policy implementation process is actually achieved. The implementation of complex marine environmental protection policy requires cooperation and communication amongst key institutions and actors, and necessitates establishment of clear hierarchies, detailed objectives, and specific roles and responsibilities of those implementing policy. We conducted semi-structured interviews with MPA managers, practitioners and policy makers across several Australian jurisdictions. Qualitative data from interviewee responses were categorised, and themes identified. Our results provide evidence for future improvement of policy development, implementation processes, and MPA outcomes in Australia and beyond.

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IMPACTS OF INVASIVE LIONFISH ON NATIVE FISHES FOUND ON CONTIGUOUS CORAL REEFS SURROUNDING LITTLE CAYMAN ISLAND, BVI (Abstract ID: 29631)

Indo-Pacific lionfishes in the western Atlantic Ocean and broader Caribbean region generate concerns about reduced abundances of native fishes, increased competition with native piscivores and disrupted trophic interactions. Many hypotheses regarding potential consequences of the invasion arise from studies of patch reefs, but studies of larger, contiguous reefs should yield broader insights that will improve management. On such reefs off Little Cayman Island, BVI, lionfish were culled from 3 experimental sites in each quarter for 3 years. In conjunction, lionfish and potential prey fishes were counted along 50 m x 2 m transects at each of the culled sites and at 3 nearby control sites. Culls maintained reduced numbers of lionfish, and analyses indicated a broad diet and a shift to piscivory for 1-4 year-old lionfish. Counts of 89 potential prey species did not indicate ecologically important variation in presence/absence, diversity or evenness between culled and control sites. Twenty-seven species exhibited ecologically important differences in abundance, with multiple species commonly found in lionfish stomachs being more abundant at culled sites (e.g., blue chromis, Creole wrasse, masked goby, fairy basslet and blackcap basslet). The remaining 62 species were more abundant at sites with lionfish, or they exhibited variable abundances. Thus, this study provides insight into the feeding habits of lionfish, a valuable documentation of "realized" impacts from lionfish predation and reason to believe that detrimental impacts can be managed effectively using culling.

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IMPACT OF GROWTH ANOMALY ON GENE EXPRESSION IN THE CORAL *MONTIPORA CAPITATA* (Abstract ID: 30008 | Poster ID: 27)

Growth anomaly (GA) is a coral disease of unknown etiology that affects corals around the world. GA exhibits high prevalence in a common Hawaiian coral, *Montipora capitata*, at the study site in Waiopae, Hawaii. We used RNA-seq to analyze coral tissue from healthy colonies, GA lesions, and apparently healthy regions of GA-affected colonies to explore the molecular pathology of GA. To isolate the transcriptional patterns of coral holobiont constituents, our *de novo* transcriptome assembly was filtered into putative coral (15,585) and *Symbiodinium spp.* (21,265) transcript subsets. Both coral and *Symbiodinium* transcriptomic patterns were most highly correlated with the *Symbiodinium* clade harbored by the host, with 1,767 and 7,804 differentially expressed genes, respectively (FDR>0.001, FC>2). Despite such strong influence of *Symbiodinium* clade on host transcription (detailed in another presentation), we identified 121 coral genes that were differentially expressed among tissue types (FDR>0.05, FC>1.4), while no *Symbiodinium* genes showed differential expression among tissue types. Pair-wise comparisons of coral gene expression among tissue types revealed the greatest difference between GA lesions and healthy colonies. The functions of these genes are consistent with reported physiological impacts of GA on coral, and may provide hints to understanding the etiology of this disease. This study shows the utility of RNA-seq to understanding molecular pathology, as well as the interactions among coral host and symbiont.

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SOFT CORALS AS QUORUM SENSING MIMICS? NEW PERSPECTIVES ON WELL-KNOWN COMPOUNDS (Abstract ID: 30168 | Poster ID: 152)

Quorum Sensing (QS), a mechanism coordinating gene expression across bacterial populations, is a potential pathway of interaction between a host organism and its associated microbial community. QS signal molecules are extracellular, allowing their interference and mimicry. The active site of, acyl homoserine lactones, well-known QS signal molecules, includes an oxygenated ring. Many Alcyonacean soft corals contain cembranoid diterpene metabolites that possess similar structural features. Bioactivity in cembranoid diterpenes have been heavily studied but no consensus has yet been reached on their *in situ* ecological roles. This study investigated the potential for QS to mediate interactions between soft corals and their associated bacteria with four questions. 1) Do soft coral extracts demonstrate QS activity; 2) Do bacteria associated with soft coral surfaces utilise QS systems; 3) Is any QS activity due to cembranoid diterpenes; and 4) Is there QS activity in the absence of cembranoid diterpenes? Bacterial biosensors in combination with chromatography, structure elucidation and molecular biology techniques were used to address these questions. QS activity, both induction and inhibition, was prevalent amongst soft corals extracts and bacterial isolates tested. Variations in the oxygen ring of cembranoid diterpenes resulted in a change from QS induction to QS inhibition. Finally, the presence of a non-cembranoid diterpene QS mimic was established in the soft coral *Nephthea brassica*. Results suggest QS interference may help mediate bacterial communities.

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DIVERSITY IN SPONGE HOLOBIONT FUNCTIONING: THE ROLE OF MICROBIAL ABUNDANCE, HOST SPONGE IDENTITY, AND GEOGRAPHY (Abstract ID: 29719)

Although marine sponges are frequently placed into functional categories based on their overall microbial abundance (High and Low Microbial Abundance [HMA and LMA]), recent research has shown that these communities and overall interactions are highly variable across individual species. To elucidate the role that overall microbial abundance, photosymbiont abundance, host sponge identity, and geography play in holobiont C and N cycling, we used a stable isotope approach in conjunction with multivariate and ellipse-based analyses. This allowed us to evaluate the core isotopic niche of a species or group and investigate factors driving the placement of individuals within isotopic space. Up to 14 sponge species were collected from three Caribbean sites (Panama, Honduras, and Belize), the Florida Keys, and a temperate reef off Georgia, USA. Some variation was attributed to geographic location, but this effect was greatly minimized when data from the temperate reef were excluded. Within individual sites, HMA and LMA groups filled unique niche space. However, host identity accounted for at least 70 percent of the variation in isotope values within a site, while photosymbiont and overall microbial abundance accounted for a much lower proportion of this variation. Together these data suggest that microbial symbionts may allow sponges to expand into novel niche space on tropical reefs, but species placement within isotopic space is relatively stable and is likely structured more by host-specific microbial community composition than by overall microbial or photosymbiont abundance.

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ON THE DISTRIBUTION OF REMOTELY SENSED CORAL REEF REFLECTANCE WITHIN THE HAWAIIAN ISLANDS AND PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT (Abstract ID: 28396)

Coral reefs are among the most diverse, productive ecosystems worldwide & provide economically important services to many coastal nations. Within the state waters of Hawai'i the net economic contribution of coral reefs is approximately $360 million/year & the overall value is estimated at nearly $10 billion. Coral reef health, diversity, & cover are thought to be declining globally in response to pressures from human activity & climate, resulting in the need for more efficient & accurate monitoring methods. Thus, remote sensing from aircraft & satellites is viewed as a potentially important tool for reef ecosystem scientists & resource managers alike. As a test of potential remote sensing application, spatial & temporal gradients in remotely sensed coral reef reflectance are investigated for reef systems within the Hawaiian Islands & adjacent waters of the Papahānaumokuākea Marine National Monument. Spectral reflectance is used to estimate coral reef ecological state, expressed as combinations of three spectrally unique regimes: 1) healthy calcifying corals, 2) turf and coral rubble-dominated, & 3) fleshy macroalgae. Remotely measured coral reef reflectance is verified with reflectance models using in situ measurements of benthic reflectance. Coral reef regime is derived as a function of location & time from remotely sensed imagery collected via aircraft & satellites. Computed spatial & temporal gradients in regime coverage is explored as possible functions of direct human impact, e.g., proximity to population centers, & climate, e.g., water temperature.

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ASSOCIATIONS BETWEEN CORAL REEF SOUNDSCAPES AND TROPHIC GROUPS IN THE HAWAIIAN ISLANDS (Abstract ID: 27902)

Passive acoustic evaluation and monitoring of coral reefs may offer a fast, quantitative technique that reveals aspects of ecological function important for resource management. Here we report associations between visually observed nocturnal and diurnal reef

ecology, and spectral aspects of reef soundscapes from 23 sites throughout the Hawaiian archipelago. Results integrated over all field sites suggest that larger, highly mobile predatory fishes were correlated with low frequency (< 2 kHz) daytime and evening sound levels. The presence of small benthic fish and herbivorous fishes were also correlated with sound levels in this band. Reef-based predatory fishes were correlated with higher frequency (1-20 kHz) evening sound levels. The nocturnal presence of benthic crustaceans was also associated with evening sound levels in bands up to 20 kHz. In addition to an association with sound level magnitudes, variability in observed numbers of crustaceans, herbivorous fishes, and echinoderms was correlated with the temporal variability of the soundscape components with which their presence was associated. These results suggest that sound levels in certain frequency bands are associated with unique groups of organisms, and that predators may use these sounds as cues to seek areas where appropriate prey are more abundant. Cost-effective and more accurate coral reef monitoring techniques are urgently required. Using associations such as these, remote and autonomous passive acoustic recording devices may be used to identify reef areas where ecological functionality is more robust.

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EVIDENCE FOR FINE-SCALE NICHE PARTITIONING OF *PARACIRRHITES*-SPECIES AT FLINT ATOLL (SOUTHERN LINE ISLANDS) VIA METAGENOMIC ANALYSIS OF GUT CONTENTS (Abstract ID: 30051)

Niche partitioning and trophic/functional versatility are known to influence patterns of speciation among coral reef fishes. Current trophic designations of reef fishes are coarse, however, suggesting dietary overlaps which seemingly conflict with Gause's law of competitive exclusion. Fine-scale differences in diet beyond that of traditional designations are likely, but perhaps undescribed. Hawkfishes in the genus *Paracirrhites* are an apt model system with respect to speciation and ecological niche differentiation, exhibiting striking differences in coloration in addition to described differences in habitat and potential foraging preferences. Fish from four*Paracirrhites* species were collected from Flint Atoll in the Southern Line Islands of the Republic of Kiribati. Analysis of the metagenomic data from hindgut samples revealed differences in taxonomic composition of microbiomes. Two species (*P.arcatus* and *P.xanthus*) showed non-significant separation of microbiome taxonomy (including comparability of two color morphs of *P.arcatus*), while *P.nisus* and *P.bicolor* revealed distinct gut flora. Intriguingly, an analysis of overall metagenomic data, including presumed prey abundance, revealed further evidence of partitioning among species. This included separate clustering of the two color morphs of *P.arcatus*, potentially reflecting an example of incipient speciation driven in part by foraging preferences. In all, diets of related reef fishes hold potential to be much more complex than previously described.

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LARGE-SCALE CORAL REEF RESTORATION IN SEYCHELLES ADAPTED TO CLIMATE CHANGE (Abstract ID: 29566)

We completed large-scale coral reef restoration at Cousin Island Special Reserve, Republic of Seychelles, to recover coral loss due to the 1998 El Nino-Indian Ocean Dipole and 2004 Indian Ocean tsunami. Using "coral gardening", first, we harvested fragments from donor colonies or corals of opportunity and reared them in mid-water rope nurseries for 1-2 years. Second, we transplanted the nursery corals to a degraded reef site. Nine nurseries built with recycled materials had 40,000 coral fragments of 9 species: Acropora hyacinthus, A. cytherea, A. abrotanoides, A. sarmentosa, A. muricata, A. lamarcki, A. appressa, Pocillopora verrucosa and P. grandis. After hurricane and invasive sponge losses, we transplanted 24,431 corals to a degraded reef site during December 2012-April 2013 and November 2013-April 2014. Mean coral survival from nursery to transplantation was 86.5 %. The restored area was 5,225 m2. We scaled-up experimental-sized restoration techniques. We developed time-saving "cleaning stations", so fish conditioned corals prior to transplantation. Animal-assisted cleaning at nurseries reduced person-hours 2.75 times. The restoration enhanced coral settlement and recruitment, increased fish biomass, and had lower bleaching rates than natural reefs. The use of cement and natural substrate to transplant corals, big nursery-reared colonies (10-20 cm wide), high transplant density (4-8 corals/m2) and a species composition similar to a healthy coral reef were critical for success. Large-scale coral reef restoration is feasible, affordable, and restores ecosystem function

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HUMAN-INDUCED GRADIENTS OF REEF FISH DECLINE IN THE HAWAIIAN ARCHIPELAGO VIEWED THROUGH THE LENS OF TRADITIONAL MANAGEMENT (Abstract ID: 29077)

Large declines in reef fishes in Hawaii over the past century have raised concerns about the sustainability of these resources and the ecosystem as a whole. To help elucidate the reasons behind these declines, we conducted a comprehensive examination of reef fishes across the entire Hawaiian Archipelago by synthesizing all available visual survey data since 2000 into a single database representing > 25,000 surveys. The moku or district was the basic unit of marine resource management in pre-contact Hawaii and was used as a unit of spatial stratification. Biomass of resource species was negatively correlated with human population density among moku, however we found no such relationship for species not targeted by fishing. A number of remote areas with small human populations still support high fish standing stocks, and are likely important refugia for maintaining fisheries production and biodiversity functioning. Marine protected areas (MPAs) were effective in conserving fish populations, with size, age, and habitat quality important determinants of MPA success. Current centralized, top-down management is incongruent with traditional place-based management that was developed at the community level. There is increasing interest among communities and coastal stakeholders in integrating aspects of customary Hawaiian knowledge into contemporary co-management. A marine spatial planning framework should be applied that incorporates existing MPAs to create a multi-use zoning plan engaging stakeholders at all levels in order to maximize resilience of ecosystems and communities.
http://ocean.nationalgeographic.com/ocean/explore/pristine-seas/

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ONLINE FRAMEWORK FOR COLLABORATIVE ANNOTATION OF UNDERWATER IMAGERY & VIDEO (Abstract ID: 29134)

Ecologists and biologists have increasingly relied on digital video & imagery to examine and monitor coral reefs and other marine habitats. Gathering these large data streams is becoming routine, but transforming them into quantitative information for science and policy decisions, requires substantial effort by human experts. Data syntheses between and within different groups is limited by inconsistent workflows and non-standard analysis, which pose barriers to data reuse and limit collaboration. Furthermore the lack of standardised workflows often results in significant lags between data collection and scientific discovery. We present an online framework for annotating georeferenced underwater imagery & video that enables speedy access to survey data through interfacing pre-existing, decentralised online storage facilities. This new framework provides consistent, customisable annotation schemes and data management capability through map-based tools enabling the exploration, querying, analysis and synthesis of annotated visual data. A centralised repository of georeferenced annotation data catalogued in a consistent format opens up the possibility of answering 'big picture' questions and provides opportunities to access large data sets for training machine learning algorithms. These algorithms ultimately have the potential to provide a scalable, cost-effective and collaborative environment for dealing with huge volumes of seafloor image & video data that can continuously improve and adapt through input from ecologists, biologists, experts and even citizen scientists.

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GENOMIC EVIDENCE FOR ECOLOGICAL SPECIATION IN CORAL ASSOCIATED NUDIBRANCHS (Abstract ID: 29757)

Many marine species have highly dispersive larvae that can travel long distances via ocean currents. As such, there appear to be insufficient dispersal barriers in marine ecosystems to attribute the great diversity of species solely to vicariance. Corals often host other invertebrates and fishes in mutualistic or parasitic relationships. Symbiotic

relationships are known to promote ecological speciation in insect-plant systems, but this process is relatively unexamined on coral reefs. Nudibranchs in the genus *Phestilla* live and feed upon specific coral hosts. Previous work demonstrates that host shifts have occurred and may be the mechanism for speciation. We examine the roles of geography and coral host in ongoing population divergence within *Phestilla minor*. We sequenced and genotyped genome-wide single nucleotide polymorphisms (SNPs) using restriction-associated DNA from nudibranch specimens collected across Indonesia. Population structure analyses reveal strong divergence across the Sunda Shelf regardless of coral host, but on the Pacific side, populations from different coral hosts have diverged despite close proximity. These results imply that coral host acts as a stronger barrier to gene flow than purported geographic barriers in the Pacific Ocean. The existence of extremely differentiated SNPs (outlier loci) between host-separated populations reveals the important role of natural selection in this ecological divergence.

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SEDIMENT REMOVAL INCREASES TURF ALGAE GRAZING AND ALTERS ALGAL COMMUNITY COMPOSITION ON CORAL REEFS (Abstract ID: 29141)

Many abiotic factors threaten coral reefs, including sedimentation from terrestrial runoff and storm activity. Sedimentation has known negative effects on corals, reducing coral growth and reproduction and damaging live tissue. Corals also compete with turf algae growing on the reef, and herbivorous fishes can facilitate coral growth by grazing on these algae. Studies in the Pacific have shown that sedimentation can decrease herbivory by grazing parrotfishes and surgeonfishes. Herbivorous fishes on Caribbean reefs also adjust their feeding behavior across small scales, but effects of sediment cover on algal grazing are not well-studied. To test how sediments influence the behavior of herbivorous fishes on Caribbean reefs we conducted a sediment removal experiment on three reefs in the upper Florida Keys. We compared short-term changes in grazing pressure and algal cover and height on plots where we experimentally removed sediments with control plots. We found that grazers significantly reduced algal cover and length in experimental plots but not in controls. However, herbivore responses were species-specific, with grazing by some species (e.g., Sparisoma viride, Sparisoma aurofrenatum, and Acanthurus coeruleus) increasing significantly in experimental plots, while others (e.g., Acanthurus bahianus) did not change. This suggests sedimentation could indirectly harm corals by decreasing algal removal by common herbivorous fishes, but the effect may depend on the grazing species present.

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NO FREE LUNCH: IMPLICATIONS OF SYMBIOTIC RELATIONSHIPS ON THE CORAL IMMUNE RESPONSE VIA THE TRANSFORMING GROWTH FACTOR-BETA SIGNALING PATHWAY (Abstract ID: 28200)

The transforming growth factor-beta (TGF-beta) pathway is often used by parasites to promote tolerance on the part of the host. Similarly, so as to not be destroyed by the immune system, coral symbionts may suppress host immunity through this pathway. Corals are dependent upon symbiotic dinoflagellates of the genus *Symbiodinium* for their nutritional needs. However, *Symbiodinium* may upregulate host TGF-beta expression to allow for the establishment and maintenance of symbiosis. We investigated this hypothesis using a previously generated immune challenge data set. Five colonies of *Orbicella faveolata* were exposed to bacterial lipopolysaccharides. RNA was extracted from each replicate of the five colonies and analyzed using RNAseq. Differential expression analyses identified 17 differentially expressed transcripts which had potential immune function. Inexplicably, several of these immune transcripts, termed 'dysfunctional', decreased in expression following immune challenge. Bioinformatic techniques were then used to identify components of the TGF-beta signaling pathway in our resultant transcriptomes. Expression of candidate TGF-beta transcripts was correlated to expression of immune transcripts, revealing insight into the mechanisms contributing to 'dysfunctional' patterns of gene expression. The findings of this study provide new insight into the importance of symbiont modulation of host immunity in contributing to variation in coral disease susceptibility. http://www.twitter.com/laurenfuess

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PHYLOGENETIC RELATIONSHIPS BETWEEN THE ORDERS ZOANTHARIA AND ACTINIARIA (CNIDARIA: ANTHOZOA: HEXACORALLIA) UTILIZING NEWLY OBTAINED SPECIMENS FROM JAPAN (Abstract ID: 28135)

As molecular phylogenetic analytical techniques have developed, more and more knowledge about the diversity of the order Zoantharia (Hexacorallia) has been obtained over the last two decades. Order Zoantharia, characterized by the encrustation of granules into the body, had been one of the least examined orders within Anthozoa because of the few useful concrete morphological features for taxonomy. Thus, only a few zoantharians species have been used for the phylogenetic studies on higher taxa, and the phylogenetic relationships between Zoantharia and the other orders in subclass Hexacorallia remain unclear. Although in general topologies of Hexacorallia are different among various studies, most show order Actiniaria is closest to Zoantharia. Here we show results from a phylogeny constructed with mitochondrial cytochrome oxidase subunit I (COI), the most common marker for DNA barcoding, and compare with a 16S ribosomal DNA phylogeny. Until now COI has not been used much with Actiniaria. The COI phylogeny also includes newly acquired specimens from Japan (e.g. Edwardsiidae, Halcuriidae Actinerniidae Microzoanthidae, Nanozoanthidae), and the resulting phylogenetic tree shows Zoantharia and Actinaria are more closely related and less distinct than previously assumed. While the tree also shows the monophyly of Zoantharia, there is the possibility of paraphyly of Actinaria.

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VARIABILITY OF TEMPERATURE-INDUCED BLEACHING WITHIN AND AMONG CORAL COLONIES (Abstract ID: 28291)

Many studies have shown that seawater temperature anomalies can cause bleaching of anthozoans, and some studies have demonstrated that bleaching susceptibility varies among species. However, spatial variability of bleaching within the same species has not been well investigated, although it is often observed. In laboratory experiments, colonies of *Palythoa caribaeorum* were exposed to water flow at controlled temperatures. In a high-flow, high-temperature regime, upstream sides of large colonies bleached less than downstream sides, and small colonies bleached less than large colonies. The results support the hypothesis that bleaching is mitigated by high flow rates (i.e., enhanced efflux of toxic reactive oxygen species from coral tissues). Cold temperatures also cause bleaching. Colonies of *Acropora sp.* are being monitored at approximately 20 m depth off the coast of Okinawa, Japan, where bleaching has been observed during the coldest months. However, not all colonies equally bleached at low temperature, and degrees of bleaching were not uniform within a given colony. This may be due mainly to variability of local water currents, as shown in laboratory experiments or to genetic susceptibility of corals and/or symbiotic algae. Other possible factors as well as bleaching mechanisms in general, understanding of which will eventually help coral reef management and conservation efforts, are also discussed.

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NEWLY DEVELOPED "TRIGONOMETRIC METHOD" FOR AN ESTIMATION OF REEF PRIMARY PRODUCTION (Abstract ID: 29248)

Coral reef metabolism of primary production is an important indicator to assess the reef condition under various threats of environmental changes. Traditionally, measurements of reef metabolism have been carried out using a slack water method or a flow respirometry. These methods need a lot of labor for field measurement to monitor reef condition. Recently, eddy correlation study has been introduced to derive reef oxygen metabolism in the same manner as CO2 flux study on land. However, applying the land study to water environment still has some problems and it is off from practical use. We have newly developed "Trigonometric Method" (hereafter abbreviated as TriM) based on the flow respirometory to derive reef primary production. This method saves a human energy and enables to monitor the primary production for long term without frequent sensor maintenance. Three dissolved oxygen loggers were deployed to coral reef at vertex of a triangle in which a targeted reef community was included. The difference of dissolved oxygen in the water mass across the triangle was calculated to estimate oxygen flux between water column and benthic community. Light-photosynthesis curve was produced to derive community metabolisms. We applied this method to two different reef community in Okinawa, Japan (Site A and B). Higher respiration rate was obtained at Site B, which is home to coral at high coverage but also more heterotrophic organisms than Site A. This newly developed "TriM" can be a useful tool for quantitative evaluation of reef condition with respect to community primary production.

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SYMBIODINIUM CELL CYCLE CONTROL BY CORAL HOSTS (Abstract ID: 28965)

Dinoflagellates of the genus Symbiodinium are tied to an endosymbiotic life style with marine invertebrates such as reef forming corals, but via a transient free-living phase. In symbiosis, the host controls Symbiodinium populations pre-mitotically by limiting division to maintain optimum cell densities; however, this fundamental process has not been detailed at the cellular level. Using flow cytometry, we analysed the cell cycle of a broad range of Symbiodinium ITS2 types (n=15 spanning clades A-D, F) in culture. All types exhibited typical eukaryotic cell cycle progression: G1-phase (preparation for DNA replication) through S-phase (DNA synthesis) during the day, and S-phase to G2/M-phase (pre-mitotic gap and mitosis) during night. However, the proportion of proliferating (S and G2/M phase) cells differed between ITS2 types, which in part reflected differences in type-specific growth rate. Upon exposure to heat stress for select types (n=5), cells were generally arrested in S-phase, possibly reflecting enhanced DNA repair and at a cost to division. We subsequently repeated our analysis for Symbiodinium spp. in hospite of three key coral species from the Great Barrier Reef; here, Symbiodinium populations exhibited similar levels of G1-S-G2/M cells but weak phased division compared to cultures, and with little further response to subsequent sub-lethal heat stress. We discuss how, together these new observations challenge our current assumptions of cell cycle control of Symbiodinium populations, and questions current practices used for monitoring these populations in nature.

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BACK-REEF DEVELOPMENTS DURING MIS2 SEA-LEVEL FALLS: IODP EXPEDITION 325, GREAT BARRIER REEF (Abstract ID: 28898 | Poster ID: 387)

Sediment cores recovered from the shelf edge of the Great Barrier Reef during the IODP Expedition 325 record the course of sea-level changes as well as the history of coral-reef developments during the last glacial cycle. Although extensive studies have been conducted on reef growth patterns during interglacial highstands, reef growth patterns during glacial lowstands have not yet been fully understood. Here we show that back reef flats were formed after sea-level fall during Marine Isotope Stage (MIS) 2 based on fossil foraminiferal data. Unconsolidated carbonate sands found in depths from 120 to 140 mbsl at the Hydrographer's passage contained abundant large benthic foraminifers (LBFs). The taxonomic composition of LBF assemblages indicated a shallowing upward sequence in these intervals, with changing from fore-reef assemblage dominated by Amphistegina and Operculina to back-reef assemblage dominated by Baculogypsina and Calcarina. Radiocarbon ages of foraminiferal tests were consistent with the timing of lowering sea levels during MIS2 revealed from radiometric ages and paleo-water depths of coralgal assemblages. Relative abundance of well-preserved Baculogypsina tests in these intervals indicates that depositional environments were closer to reef margins. These foraminiferal evidences suggest that remnants of biologically constructed barriers such as coralgal reef crests existed offshore associated with sea-level falls, possibly causing moating effects. Our results would also imply paleo-intertidal water levels during the Last Glacial Maximum.

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CHANGES IN MESOPHOTIC REEF FISH ASSEMBLAGES IN THE NORTHWESTERN HAWAIIAN ISLANDS ALONG A LATITUDINAL AND LONGITUDINAL GRADIENT (Abstract ID: 28439 | Poster ID: 341)

Mesophotic coral ecosystems (MCEs) are characterized by the presence of light-dependent corals and associated fauna at depths below 30 m and support a diversity of marine organisms. We investigated changes in the structure of mesophotic reef fish assemblages in the Northwestern Hawaiian Islands (NWHI) along a latitudinal and longitudinal gradient, using survey data from 27 - 92 m depths. There was a clear gradient in the assemblage structure from the southeastern end to the northwestern end of the NWHI. The three atolls at the northwestern end of the NWHI (Pearl and Hermes, Midway and Kure) had higher abundances of two endemic planktivores, *Genicanthus personatus* and *Pseudanthias thompsoni*, and a temperate species, *Centropyge interrupta*, than all other locations. An endemic invertivore, *Bodianus sanguineus*, was also relatively abundant on deeper mesophotic reefs of these three locations. The two locations at the southeastern end of the NWHI (Nihoa and French Frigate Shoals) were characterized by high abundances of the introduced invasive species,*Lutjanus kasmira*; this species was only recorded at these two locations with an exception of one individual at Lisianski Island. This study indicates that MCEs in the NWHI can be treated as three regions for monitoring and management purposes: southeastern and mid regions characterized by the presence/absence of the invasive fish *L. kasmira*, and a northwestern region where fish assemblages, largely composed of endemic species, can be influenced by cooler temperate climate.

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FROM FISHING FISH TO FISHING DATA: CITIZEN SCIENCE, CONSERVATION AND MANAGEMENT IN FISHING COMMUNITIES. (Abstract ID: 28259)

The participation of artisanal fishers in conservation and management rarely goes beyond providing traditional ecological knowledge to visiting scientists and managers. Communities are often excluded from monitoring, evaluation and decision-making, despite potential impacts on livelihoods. For 15 years, we have implemented a citizen science-monitoring program in three key marine ecosystems in Mexico: the coral reefs of the Mesoamerican Reef, the kelp forests of Baja California and the rocky-reefs of the Gulf of California. We have designed, tested and implemented the community-monitoring model in collaboration with local fishers, achieving science-based conservation and management decisions and improving livelihoods. Through collaborative research fishers have collected data to calculate quotas, biologically evaluate 11 MPAs, propose the establishment of 22 no-take zones, contribute to scientific publications and implement conservation and fishery management tools for over 620,000 hectares of coastal waters. Over 400 community members have participated in the marine reserve program, of these, 174, including 30 women, have been trained to conduct underwater censuses, completing over 12,000 transects with internationally recognized methodologies. Both civil society and government in Mexico and neighbouring countries are now adopting this successful model. Empowering community members to collect scientific data creates responsibility, pride and a deeper understanding of the ecosystem in which they live and work, providing both social and ecological benefits to the community.
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SURVIVAL OF THE SMALLEST: CRYPTIC CELLS LIVING IN DEAD CORAL SKELETON (Abstract ID: 29855)

Corals are modular organisms with the surprising ability to survive and regrow after breaking into pieces. How small is too small to survive? Coral reefs have maintained life through natural global changes for thousands of years but are currently faced with the most dramatic change yet. Corals can recover from stress by regrowing from cryptic tissues. Cryptic tissues are made of coral cells that survive in recessed or shaded areas of the reef, often not visible by standard coral surveys. These tissues are known to give corals the ability to return to life from apparent death. For some species, survival at a small scale can lead to a population-scale recovery. This study tests the boundaries of coral life and death. By microscopically exploring apparently dead coral skeleton, we used hyperspectral mapping microscopy and genetic approaches to search for living coral cells hidden inside the skeletal matrix. Within the skeletal matrix of recently 'dead' coral colonies, we found live, fluorescing, coral cells. Like most cnidarians, coral cells are effectively stem cells with the capacity for cellular differentiation and colonial development. The cryptic coral cells were found well beneath the coral skeletal surface, suggesting that individual cells can survive away from surface stressors, and perhaps re-grow, once external conditions have improved. This study changes what constitutes a "dead" reef and could have lasting impacts on coral reef conservation.

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DEVELOPMENT OF A SIMPLE AND EASY-TO-USE MULTI-WAVELENGTH EXCITATION *IN-SITU* FLUORESCENCE IMAGING APPARATUS (Abstract ID: 28694 | Poster ID: 500)

Numerous marine organisms, including corals, have fluorescent substances such as green fluorescent proteins. Coral fluorescence has been shown to vary with coral health and environmental factors, making it a possible non-destructive proxy for coral health. However, due to the lack of adequate system for *in-situ* observation, available data are rather limited. We developed a system which simplifies the fluorescence imaging of corals in night and day conditions in the field, using excitation light of 470nm and a cut filter of 470nm to emphasize green-red fluorescence. The system was tested by monitoring coral fluorescence *in-situ*, along with environmental data, for an extended period of time, showing the effectiveness of the system. In addition to green fluorescence, red and blue fluorescence, due to photosynthetic pigments and other fluorescent proteins, can be observed. Based on the measurement of the fluorescent spectra of several coral species and marine organisms, we then made a "handy multi-fluorescence imaging apparatus" with six excitation lights (470, 530, 591, 617, 655 nm, and white (5650k)) and five cut filters (<390, <480, <540, <620, <640nm). This system allows the imaging of not only the conventional blue to red wavelength but also longer wavelength such as deep red fluorescence. In the future, such method will make it possible to understand the relation between corals' fluorescence and their physiology, and to provide an useful monitoring tool for more effective marine ecosystems managements and environmental impact assessments.

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THE EFFECT OF SYMBIONT DIVERSITY ON INFECTION PATTERN, SYMBIONT CELL PROLIFERATION AND PHYSIOLOGICAL STATUS IN A MODEL CNIDARIAN-DINOFLAGELLATE SYMBIOSIS (Abstract ID: 29318)

Warming ocean temperatures increase the frequency of mass coral bleaching events, which might lead to changes in coral symbiont communities that would not necessarily be beneficial to the host. The genus Symbiodinium is characterized by a high degree of genetic and physiological diversity, therefore it is an important driver that can influence the symbiosis. This study examined for the first time the functional diversity of a wide range of Symbiodinium phylotypes on cnidarian host, by infecting aposymbiotic individuals of the model sea anemone Aiptasia sp. with one of five types of dinoflagellates (Symbiodinium A1, B1, C3, D1.A, E) over a period of eight weeks. The spatial pattern of infection and physiological parameters were monitored. Infection began in the oral disc and progressed to the tentacles. After the tentacles were heavily infected, the infection continued to the column and pedal disc. No differences were found in the infection pattern between different Symbiodinium types, however symbiont proliferation rate was different between the types. The homologous type B1 colonized the anemone the fastest, while A1 and D1.A were slower to fully infect and reached lower densities than B1. C3 and E showed few signs of infection. There were also differences in physiological parameters tested between anemones infected with different symbiont types. For example, anemones infected with B1 were much bigger and had more buds compared with the other types. These findings suggest that cnidarian hosts might be able to survive with heterologous types that are considered opportunistic; however, there may be physiological costs, such as lower growth and reproductive rates

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BALANCING INTROGRESSION AND SPECIES INTEGRITY ACROSS A MOSAIC HYBRID ZONE (Abstract ID: 28467)

Hybridization among coral reef taxa has been well documented, particularly in corals and more recently in fishes. Hybrid zones offer rare opportunities to study interspecific gene exchange in nature and may provide valuable insight into the evolution of species, where tension between gene flow and selection can result in mosaic ecological and genetic patterns. In this way, hybridization may act to fuse parental populations and remove species, or lead to new species through reinforcement in time. The natural hybrid zone of the anemonefish Amphiprion leucokranos presents an ideal study system to investigate regional differentiation among species involved in an ongoing hybridization. We examined phenotypic variation, ecological resource use, mate preference, and gene exchange across parent species and hybrid populations at three sites within the hybrid zone. Historical and contemporary estimates of gene exchange were derived from mitochondrial cytochrome b and 21 polymorphic microsatellite loci. We found that evolutionary outcomes for species involved in this hybridization event vary regionally, and are potentially driven by the availability of conspecifics. Our results also reveal the persistence of the hybrid group within all regions, appearing both phenotypically and genetically (using nuclear microsatellite loci) distinct from parent species despite the ongoing backcrossing and introgression occurring. Our data suggests that over time this hybridization event may lead to speciation of the white-bonnet anemonefish, highlighting the balance between hybrid persistence and maintaining parent species integrity in a dynamic hybrid zone.

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FISHES THAT RULE THE WORLD: CIRCUMTROPICAL DISTRIBUTIONS REVISITED (Abstract ID: 28023)

Briggs (1960) published the first annotated checklist of circumtropical fishes with 107 species. This work served for a half century as the most comprehensive checklist of globally distributed fishes, but the intervening years witnessed many discoveries and molecular data have changed the way we evaluate species. Here we update the list guided by taxonomic revisions, phylogenies, phylogeographic data and DNA barcodes. The resulting list now includes 284 species. The dramatic increase is primarily due to continued exploration of the seas leading to species discoveries and public databases make range data more accessible. Five species were removed from the list as closer scrutiny revealed multiple taxa, 14 were removed due to updated range information, and 35 more are suspected to be species complexes. The species listed here are mostly pelagic and bathypelagic fishes. Euryhaline, anadromous, catadromous, freshwater, and with few exceptions, reef fishes do not achieve global distributions. The most species-rich family of marine fishes (gobies) is absent. The fishes with the longest pelagic larval stage (eels) are absent. In contrast, requiem sharks, tunas, jacks, remoras and especially lanternfishes have multiple representatives. The combined evidence indicates that high mobility as an adult is a key requirement to achieve global distribution. Many others are members of monotypic genera or families, indicating old lineages that did not diversify. We conclude that global ranges may promote persistence over evolutionary timescales, but also reduce opportunities for speciation.
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RELATIONSHIPS BETWEEN HABITAT, SOCIAL BEHAVIOUR AND DIET: A CASE STUDY IN DAMSELFISHES FROM MOOREA (Abstract ID: 28446)

Models for vertebrate adaptive radiations predict that diversification occurs in the form of temporal stages. Generally, adaptive radiation happens first along the axis of habitat features and then follows a divergence related to trophic specializations. Here, we aim to test this hypothesis by investigating the relationships among habitat, social behaviour and diet in damselfishes (Pomacentridae) from coral reefs at Moorea, French Polynesia. Stable isotope ratios of carbon and nitrogen in combination with stomach contents delineated three trophic groups, as observed in other regions: pelagic feeders consuming zooplankton, benthic foragers mainly grazing on algae, and a group called intermediate that feeds on zooplankton and benthic preys in equal proportions. Stable isotope ratios of sulphur revealed a segregation between species of the outer reef, which are mostly dependent on oceanic food input, and the other species from the lagoon, which rely more on autochthonous local productivity or even on terrestrial supply. Without phylogenetic corrections, the diet of damselfishes defined with stomach contents was correlated with habitat and social behaviour, and it was also correlated based upon stable isotopes. Furthermore, with phylogenetic corrections, significant relationships were found for either dietary proxy. Overall we demonstrate a dependence between habitat and trophic diversification during the evolutionary history of damselfishes, providing no support for a model of adaptive radiation in stages.

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USING BIO-OPTICAL MODELS OF CORAL CALCIFICATION TO EVALUATE THE EFFECTS OF GLOBAL CHANGE (Abstract ID: 29700)

Coral calcification is strongly correlated to the photosynthetic activity of the endo-symbiotic dinoflagellate Symbiodinium, but other environmental factors (temperature, seawater chemistry) can also alter calcification, through the disruption of photosynthesis. In the present study, using physiological differences caused by environmental changes in light and water temperature, a bio-optical model was created, and its predictive capabilities on Porites astreoides calcification were evaluated. We described photophysiology and calcification rates between two different populations of P. astreoides. The first population was grown under optimum conditions (Back Reef, BR), while the second was grown under a natural ocean acidification (OA) scenario (subterraneous water spring, SWS). Both locations also differed in light availability and diurnal variations in water temperature, mainly due to SWS having decreased light availability and higher variations in temperature. Our results indicated differences in calcification between both coral populations as estimated by buoyant weight and densitometry analyses. Despite previous reports attributing a 35% decrease in calcification rates to OA in SWS corals relative to BR corals, our bio-optical model indicates that differences in water temperature, not OA, explains the majority of this decrease.

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AN INTEGRATIVE APPROACH TO ENVIRONMENT AND HUMAN GEOGRAPHY, THE CASE STUDY OF MAGOODHOO ISLAND-MALDIVES (Abstract ID: 28692)

Several regions around the world are currently undergoing rapid, wide-ranging changes in land use and land cover. Conversion of rural areas through development is occurring at a rate unprecedented in recent human history and is having a marked effect on natural ecosystem functioning. Pronounced climate change and land-use/land-cover change represent the two primary challenges that most ecosystems will face this century. Land-use/land-cover deeply influences biotic diversity through natural habitat fragmentation and biodiversity loss. Land-use/land-cover also has an important and extensive influence on climate by altering the distribution of ecosystems and their associated energy fluxes. In tropical coastal regions, fragile marine coral reef ecosystems, already threatened by increasing carbon dioxide, are exposed to an increased load of terrestrial sediment, nutrients, and other pollutants. It has been proved that increased sedimentation and poor water quality compromise the resistance of corals to thermal stress and their potential to recover from bleaching events. This work offers an integrative perspective on the political and ecological processes shaping landscapes and resource used in Magoodhoo, Faafu Atoll, Republic of Maldives as case study. Our research has demonstrated how union of environmental and human geography studies can contribute to understanding key environment-and-development issues and working toward effective policies.

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PILOT PROGRAM: DIVERSIFYING FISHERMEN INCOME GENERATION ACTIVITIES TO REDUCE LOCAL IMPACTS ON PUNTA CANA´S CORAL REEF COMMUNITIES, DOMINICAN REPUBLIC. (Abstract ID: 29751 | Poster ID: 559)

Coral reefs worldwide provide various social-economic services for bordering nations. However, these ecosystem services are threatened by a continued decline in reef health. In the Dominican Republic reef health is threatened the disappearance of the important reef building Acropora corals, the lionfish invasion, overfishing of herbivorous fish, an overabundance of coral predators, and tourism associated activities. Here, we present potential options for alternative income generation and to reduce local reef impacts. To combat the decline of Acropora corals and the overfishing of herbivorous fish, fishermen were hired to work 1 week/month on Puntacana Ecological Foundation´s (PCEF) coral restoration program. These same fishermen land on average 16.60kg of fish/day/ind. of which 49% is parrotfish. This restoration work week saves approximately 56.8kg of parrotfish/ind. and earnings for 4 weeks of work is equivalent to 88% of their fishing income. Similarly, fishermen family members are helping with invasive species by commercializing lionfish-based products, supplementing their monthly family income by 18.4%. Tour operators and PCEF are developing new excursions in which tourists are involved in coral restoration and work with fishermen to reduce the overabundance of fireworms using traps as a new income source. These income generation activities can be easily replicated and as new projects are added that fund these activities, will continue to be attractive for fishermen, allowing local stakeholders to reduce reef impacts without excluding local community participation.
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COLOMBIAN CITIZEN SCIENCE TO IMPROVE CORAL REEF CONSERVATION (Abstract ID: 27854)

The Foundation ICRI Colombia through its Observatory in Pro of Coral Reefs and its National Network of Volunteer Observers of the Coral Reefs (RENOVO) worked in a Coalition under the principles for conservation effectiveness: 1) Environmental Management is about people 2) The local knowledge should be taken into account when decisions are made 3) Monitoring is relevant for adaptive management. Scientific results are based on eight years of data collection in collaboration with the community of artisanal fishermen and diving operators. The daily observations were reported in a systematic way to monitor fishing and dive sites in coral reef areas in Colombia. Qualitative reports based on underwater videos and photos, served to study the progression of the invasion of Lionfish Pterois volitans in the Colombian Caribbean and to identify species to be protected in the new coral reef Varadero, Cartagena. The quantitative data gathered as Catches Per Effort Unit (CPEU) also was useful to monitor since 2009 the changes in artisanal fisheries composition in Capurganá-Cabo Tiburon after the appearance in 2010 of the invasive lionfish. The RENOVO´s citizen science successfully contributed to provide environmental education to the community that became the best guardian of the coral reefs improving the conservation effectiveness and provided information to the national, regional and local authorities to guide better conservation decisions, such as implementing the route for the declaration of the new coral reef protected area Capurganá-Cabo Tiburón and help avoiding Varadero destruction
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REEF-SCALE STUDIES OF BOUNDARY LAYER FLOWS AT DIFFERENT BOTTOM TYPES (Abstract ID: 29355 | Poster ID: 522)

The boundary layer is a layer that is affected by the shear stress produced near the bottom boundary in which large velocity gradients exist. The thickness of bottom boundary layers (BBL) is characterized by water velocity, shear stress and roughness element. Flows over spatially varying bottom topography of the coral reef have been known to influence settlement, retention and dispersal of particles and can be linked to frictional forces imparted by the complexity of the boundary. This study focused on understanding the hydrodynamic processes at the boundary layer over a coral reef area to provide valuable insights on the ecological functions of the reef ecosystem. The flow structure and thickness of the BBL were estimated through time-series measurement of a high-resolution velocity profile over a tidal cycle at three different bottom types at fringing reef systems of Miniloc and Shimizu Island, El Nido, Palawan. Field velocity measurements were analyzed to provide estimates of shear stresses and roughness length over different bottom types using logarithmic fit. The study showed that flow structures, thickness of boundary layer and velocity profile changes over different bottom types due to frictional effects. From these observations, implications for particle settlement and advection are discussed. In conjunction with this reef scale study, 2D (X-Z) hydrodynamic simulation was developed to describe the dynamics and structure of boundary layer flows for different bottom types. Results from actual measurements and exploratory model simulations are compared and discussed.

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ENVIRONMENTAL DRIVERS OF BROAD-SCALE DISTRIBUTION OF SPONGE COMMUNITIES ON THE MESOAMERICAN BARRIER REEF (Abstract ID: 29375 | Poster ID: 506)

Sponge communities play a vital ecological role on coral reefs. Despite the general agreement that environmental regimes influence the distribution of sponges, key mechanisms that explain patterns of sponge assemblages are not yet fully understood. We studied the spatial patterns of sponge abundance and morphological traits along the Belize Barrier Reef System against hurricanes, wave exposure and depth (5-20 m) as key drivers of their distribution, using video transect surveys. We expected that the role of these drivers would result in effects based on sponge structural robustness or morphological adaptation to hydrodynamic processes. Our analyses supported this, as under high mechanical stress (wave exposure and hurricane incidence), sponge communities were dominated by low-profile morphologies, namely large encrusting individuals that were adapted to such hydrodynamic regimes. Depth provided refuge to structurally complex, slow growing sponges, such as vase and barrel sponges. As wave exposure decreased, the depth range of certain sponge morphotypes expanded to include shallower areas. At a species level, morphological plasticity also allowed for certain sponge species to occur over a wide range of exposures and depths. Our results showcase mechanical stress as a key driver of benthic assemblages and highlight a strong morphological response of sponge species. Knowledge of these morphological trends in sponges, related to mechanical stress, provides insight into expected sponge community assemblages in other locations with similar environmental conditions.

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CALCIFICATION IN CORALLIUM RUBRUM: DISSECTING THE PROCESS USING GENOMICS AND TRANSCRIPTOMICS TOGETHER WITH SCALPELS AND SCISSORS (Abstract ID: 29459)

The Mediterranean red coral, *Corallium rubrum*, famous in jewelry for its red colored skeleton, elaborates two biominerals (high magnesian calcite) structures which differ in size, shape and organic fraction composition: 1) the axial skeleton, produced by the skelotogenic epithelial layer which surrounds the axial skeleton and 2) the sclerites, produced by the scleroblasts which are isolated cells in the mesoglea. Within the class of Anthozoa, *C. rubrum* belongs to Octocorallia, the sister group to Hexacorallia which includes sea anemones and reefs building corals. *C. rubrum* thus represents a model of choice to understand some of the evolutionary processes that govern calcification in corals: 1) what mechanistic processes control the formation of the two different skeletal structures; 2) to which extended is the calcification toolkit used by octocorallians and by hexacorallians comparable? We chose to answer these questions using genomic and transcriptomic approaches. We are currently establishing a reference genome sequence for the red coral, which size is about 500 Mb. On the other hand, we have produced transcriptomes representing different sub-compartments of the red coral: microdissection using scalpels and scissors enabled the physical separation of different tissues, enriched in or devoid of calcifying cells, for differential expression analyses. These combination of approaches shed light on some of the processes linked with calcification in *C. rubrum* for both the organic and the mineral part.

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ATMOSPHERIC CORRECTION OF PRISM AIRBORNE IMAGING SPECTROMETER DATA FOR SUPPORTING CORAL REEF RESEARCH (Abstract ID: 28081)

The COral Reef Airborne Laboratory (CORAL) is a recently funded NASA project. The goal of CORAL is to provide critical data and new models that are needed to analyze the present status of coral reefs and to predict their future. The NASA JPL Portable Remote Imaging Spectrometer (PRISM) will be mounted on a small plane and deployed over a number of coral reef sites in the coming years. Atmospheric correction is necessary in order to obtain water leaving reflectance spectra over coral reefs. During past few years, we have developed techniques that involved theoretical radiative transfer modeling and empirical removing of sunglint effects for atmospheric correction of PRISM data. In early 2014, PRISM already acquired hyperspectral imaging data over coral reefs southwest to Florida during a different airborne field campaign. We will further develop the atmospheric correction algorithm, and apply the algorithm to the PRISM Florida data set. We will describe the algorithm and present results from application of the algorithm to the PRISM data during the symposium.

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TRANSBOUNDARY MANAGEMENT OF CORAL REEF COMMERCIAL FISHERIES USING LARVAL CONNECTIVITY. (Abstract ID: 28701)

Coral reef commercial fisheries represent one of the main economic resources in the Caribbean region. Each Caribbean nation manages its own fishery stocks, typically at the national scale. However, targeted populations are structured in metapopulations that are connected through larval dispersal across national boundaries. One of the main challenges for an effective management applied to these metapopulations is the need of partnering between countries that share the same resource. In this study, we focus on the highly valuable commercial fishery of the spiny lobster Panulirus argus. The broad-scale larval dispersal patterns of this species have been assessed in the Caribbean region but no transboundary management has been proposed for this important resource. We coupled a biophysical larval dispersal model and a metapopulation dynamic model at reef scales to obtain a finer-grained representation of connectivity and dynamics of spiny lobster across the Caribbean. We analyzed the spatial heterogeneity in patterns of the species dispersal both within and across national boundaries and evaluated the scales of larval exchange and self-seeding in the Caribbean region. Based on these results we propose trans-national neighborhoods for spiny lobster management scale that are adapted to the scale dynamics of spiny lobster metapopulation dynamics.

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GENOMIC ANALYSIS OF DISJUNCT PACIFIC AND SEA OF CORTEZ POPULATIONS OF A REEF FISH (GENUS: *ANISOTREMUS*) (Abstract ID: 29954)

Disjunct populations are formed after a physical barrier separates the populations of a species, which then has the potential to remain the same species or diverge depending on how effectively the barrier impedes gene flow. Disjunct populations provide an excellent opportunity to study the evolutionary processes of allopatric speciation. The sargo, *Anisotremus davidsonii*, has a disjunct distribution with populations in the Pacific coast of California and northern Baja California and isolated populations in the upper half of the Sea of Cortez. These disjunct sargo populations have been suggested to be at the initial phases of allopatric speciation. This project utilizes restriction site associated DNA (RADSeq) to produce a highly confident connectivity analysis of populations sampled across the Pacific and Sea of Cortez ranges of the sargo. The goals of this project are to (1) characterize the genetic structure of these populations and assess divergence levels across the Baja California peninsula, (2) determine the connectivity within each region and (3) explore the molecular signatures of incipient allopatric speciation. This study sheds light into the processes in the speciation continuum in this species and provides a deeper understanding of how populations are connected and how biodiversity might be shaped in these regions.
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EXPLORING THE ISSUE OF BOTTOM REFLECTANCE PARAMETERISATION IN SHALLOW WATER INVERSION MODELS (Abstract ID: 29261)

A key processing step in the optical classification of benthic substrates from hyperspectral imagery of coral reef environments is correcting for the radiometric effects of the water column to derive bottom reflectance. Shallow water inversion models are a proven methodology able to simultaneously retrieve the water column's inherent optical properties (IOPs), geometric depth and bottom reflectance from remote sensing reflectance with little or no in situ data. However the accuracy of the retrieved IOPs and depth is influenced partly by the spectral shape of the benthic endmember(s) that are input to

the inversion model. Current inversion schemes parameterise the bottom reflectance as a single or a linear mixture of two or three benthic endmembers. However, the efficacy of these parameterisations remains untested given the narrow water column penetrating bands and the exponential attenuation of light with depth. Here, we analyse three parameterisations of bottom reflectance previously published: (1) a single endmember scaled by its brightness; (2) the fractional coverage of two endmembers, and; (3) a linear mixture of three endmembers. Here each parameterisation utilises the same IOP model and optimisation algorithm allowing for more readily comparable results. Issues such as over-parameterisation and the ability to detect benthic mixtures from above water reflectance will also be addressed. We evaluate these approaches using both in situ radiometry and airborne imagery from NASA's Portable Remote Imaging SpectroMeter (PRISM) of coral reefs.

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IMPORTANCE OF THE THREATENED ACROPORA CORALS FOR THE CONSERVATION OF REEF FISHES (Abstract ID: 29398 | Poster ID: 259)

A high proportion of reef fish species use branching scleractinian corals as shelter, breeding, and feeding sites. In the Caribbean, coral reefs have suffered a drastic decline, which has been found to affect economic activities such as fishing, tourism, and conservation. Branching corals of the genus Acropora have been widely decimated with mortalities reaching in some places over 90%. This study surveyed and evaluated visually the fish community associated to the two Caribbean species of Acropora at five localities along the continental Colombian Caribbean reefs. The best conserved A. palmata patches were found in Tayrona Natural Park, while Gulf of Uraba shelters the best conserved A. cervicornis reefs. 61 fish species of 25 families were associated to A. palmata; the families better represented in those habitats were Labridae, Haemulidae, Pomacentridae, and Serranidae. Thalassoma bifasciatum, Microspathodon chrysurus, and Stegastes adustus were common to all reef localities; San Bernardo Islands presented the largest number of species (44). 33 species included in 11 families were seen in A. cervicornis patches. Labridae, Pomacentridae, and Haemulidae were the most abundant. Stegastes planifrons was common at all localities; the greatest number of species was found in Uraba Gulf (29). Although topography provided by A. palmata was relevant to the abundance of fish, high coverage of A. cervicornis was a significant factor that allowed for greater complexity for the associated fish community.

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MESOPHOTIC REEF SPONGES (PORIFERA) FROM PUERTO RICO AND THE US VIRGIN ISLANDS (Abstract ID: 27802)

The marine sponges collected during three research cruises conducted by the University of Puerto Rico at Mayagüez Caribbean Coral Reef Institute and Department of Marine Sciences are described and discussed. Over twenty sites were surveyed by scientific divers using closed circuit rebreathers at depths ranging from 50 to 80 m. The goals of the expeditions were to characterize mesophotic coral ecosystems starting from Isla Mona (West coast Puerto Rico) along the south coast of Puerto Rico heading towards the US Virgin Islands and concluding at Lang Bank off the eastern end of St. Croix. A total of 84 specimens were analyzed and incorporated in the collections of the Naturalis Biodiversity Center (Leiden, Netherlands). Sponges belonging to the classes Homoscleromorpha and Demospongiae were analyzed. A total of 7 sponge species belonging to the class Homoscleromorpha were analyzed, all belonging to the Family Plakinidae. The remainder 68 sponge specimens belonged to the class Demospongiae. In total, eight Orders were identified during our preliminary analysis: Haplosclerida (19 species), Agelasida (7 species), Dictyoceratida (7 species), Poecilosclerida (5 species), Verongiida (5 species), Suberitida (5 species), Axinellida (3 species), and Tetractinellida (3 species). Based on our preliminary taxonomic analysis, we report four new sponge species from this region. This is the first systematic study of mesophotic reef sponges from Puerto Rico and the US Virgin Islands, and will serve as the foundation for future studies regarding this understudied group at these depths.

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IMPROVING RESILIENCE THROUGH CORAL RESTORATION IN NO TAKE AREAS (Abstract ID: 29857)

Coral reefs are being affected by a combination of human and natural perturbations, accentuated by global climate change. Although climate change related events are not readily controllable with local management interventions, we are able to influence to a certain extent opportunities for coral reefs to resist or recover enhancing natural resilience through active restoration. Oceanus and its partners are working to strengthen resilience and adaptation potential of coral reefs and to promote recovery of associated species of fish and invertebrates by implementing a Coral Restoration Program with special emphasis on recovering no-take areas as a part of the Kanan Kay Alliance and similar initiatives in neighboring countries. Restoration techniques developed by Oceanus involve the construction of PVC pipe nurseries planted with key coral fragments at selected sites along the Mesoamerican Reef and the Gulf of Mexico, and transplantation of thousands of colonies every year. The program includes identification and selection of genetic material from healthy donor populations that are naturally resistant to climate change and local stressors. It also seeks to engage local communities and reef managers as a part of a Restoration Network to achieve greater impact over a larger area. With strategic selection of the restoration sites and increasing the number of healthy live coral colonies genetically diverse, effects of restoration through sexual reproduction and larval dispersal is expected to result in a multiplier effect of reef rehabilitation in a larger area. http://www.oceanus.org.mx

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THE STATUS OF REEF FISH ASSEMBLAGES AROUND THE URBANIZED, SMALL ISLANDS AT THE CENTER OF THE CORAL TRIANGLE (SPERMONDE ARCHIPELAGO, SE SULAWESI, INDONESIA) (Abstract ID: 28966 | Poster ID: 659)

Reefs in Indonesia are arguably the world's most important reefal communities in terms of biological diversity and because of the populace they provide for. For the thousands of small island communities throughout Indonesia, fisheries production and livelihoods are dependent on the condition of their reefs. Yet so often little is known about the ecological 'state' of these reefs and importantly the dynamics of the fish assemblage upon them. The reefs of the Spermonde archipelago provide a valuable case study for other urbanized, island based communities throughout the Indo-Pacific. We assessed the status and trends of reef fish assemblages across the archipelago and compare associations with the benthic conditions and the socio-economic context of local communities. We found 'healthier' reef fish communities around well inhabited islands where some habitat structure is still intact. Outer and uninhabited islands are less endowed presumably because illegal fishing practices are easier to undertake on un-watched reefs. Reefs within 5km of the heavily populated mainland and major industrial cities are highly sedimented and have quite variable benthic and fish communities. Despite the relatively poor condition at present, the Spermonde reefs have a long extraction history and have sustained large human populations. Priority areas for management actions in the area include: major enhancements in targeted enforcement against destructive fishing; prioritization of sewage treatment on densely inhabited islands; and soil management practices in adjacent, mainland agricultural areas.

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THE ANTIOXIDANT ROLE OF DIMETHYLSULFONIOPROPIONATE (DMSP): CAN SULFUR HELP CORALS IN A CHANGING CLIMATE? (Abstract ID: 28865)

Corals, with their symbiotic dinoflagellates, are among the largest producers of dimethylsulfoniopropionate (DMSP) and are known to increase the production of this compound under stressful conditions. DMSP is a key molecule in the global sulphur cycle and it has been hypothesised that DMSP and its breakdown products can act as a highly effective antioxidant system in phytoplankton; however its exact function(s) in corals remains unknown. Here we investigate antioxidant mechanisms of DMSP, superoxide dismutase (SOD), glutathione (GSx) and catalase (CAT) in the host and symbionts of Acropora millepora and Stylophora pistillata under increasing temperature (27oC - 32oC). Corals exposed to increased temperatures showed a strong decline in photosynthetic efficiency, indicative of stress. This stress response correlated to an up-regulation of host SOD, GSx and CAT in both species, an increase in symbiont CAT for A. millepora and GSx and CAT for S. pistillata. Once normalised to per Symbiodinium cell, there was significant increases in symbiont SOD, GSx and CAT for S. pistillata and GSx and CAT for A. millepora. There was a significant increase in intracellular DMSP and DMSO per symbiont for both A. millepora and S. pistillata, highlighting a potential antioxidant function of DMSP under thermal stress. These findings highlight how the different responses of two common Indo-Pacific corals may be used to explain their abundance and distributions in the future under a warming climate.

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CORAL REEF STRUCTURE INDEX: A SPATIALLY EXPLICIT TOOL FOR MANAGEMENT DECISION SUPPORT IN THE WESTERN CARIBBEAN. (Abstract ID: 28062)

We present a synoptic management tool for decision support: the Coral Reef Structure Index (CoRSI) for the Western Atlantic. It is a three-pronged approach based on the coral community composition (density of colonies by species), coral cover and rugosity. It offers a common currency to objectively compare the reef structure in reef sites, zones and tracts temporally and spatially. This index can be used as stand-alone values for comparison, or can be mapped using high-resolution satellite imagery and spatial prediction techniques. Our study case, Akumal, is a very well developed fringing reef in Quintana Roo México, part of the Mesoamerican Reef, which has experienced a boom in coastal development and tourism in the last two decades, with the highest average hotel occupancy in Quintana Roo. Since 2001 it has been assessed as in critical condition with changes in the coral community composition as well as a complete phase shift with macroalgae coverage averaging 65% vs. 7% of average coral cover. Historical data from a network of monitoring stations since 2000, and archival imagery (Ikonos, WV-2, WV-3), allow, in the one hand, the calculation of CoRSI, and in the other hand, allow the mapping of CoRSI to estimate the loss of reef structure. These spatial estimates using CoRSI reflect 66% of reef structure loss in a 15 years span (2000-2015) for Akumal Reef. This result is in accordance with the historical analysis of shifts in coral community composition, the decrease in coral cover and rugosity estimates in the area.

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CRESCYNT: CORAL REEF SCIENCE AND CYBERINFRASTRUCTURE NETWORK – BUILDING DATA TOOLS AND RESOURCES FOR CORAL REEF RESEARCHERS WITH EARTHCUBE (Abstract ID: 30049)

EarthCube envisions a community-driven dynamic cyberinfrastructure intended to increase and democratize access to advanced technological and computational capabilities for geosciences research. As an EarthCube research coordination network, CRESCYNT is working to match the data sources, data structures, and analysis needs of the coral reef community with current advances in data science, visualization, and image processing from multiple disciplines to advance coral reef research and meet the increasing challenges of conservation. CRESCYNT is structured as a network of networks, including both disciplinary nodes (e.g., microbial diversity, symbiosis, disease, physiology & fitness, reef ecology, fish & fisheries, conservation & management, biogeochemistry & oceanography, paleontology, climate change) and technological nodes (e.g., visualization, geospatial analysis & mapping, image analysis, legacy & dark data, data management). Participation remains open at http://crescynt.org. CRESCYNT offers the community an opportunity to collaborate and share resources, tools, training, and solutions to current problems in the near term, as well as the chance to identify needs and influence priorities for cyberinfrastructure development for geosciences over the long term. Collaborative efforts of participants and node coordinators, identification of applicable technologies developed in other disciplines, and partnership with a broad set of valued partners particularly in other sections of EarthCube have been essential to progress so far. “Hypotheses come and go but data remain” (Cajal).
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FINE-SCALE POPULATION STRUCTURE OF TWO HOST SEA ANEMONE SPECIES IN KIMBE BAY, PAPUA NEW GUINEA (Abstract ID: 30007 | Poster ID: 521)

Anemonefishes are one of the main groups that have been used over the last decade to empirically measure larval dispersal and connectivity in coral reef populations. Ten species of sea anemone are integral to the life history of these fish, yet the biology and population structure of these anemones remains poorly understood. Furthermore, host anemones are heavily targeted for the aquarium trade and are susceptible to bleaching, so understanding their biology is crucial for developing better management strategies. This study measured the genetic structure of host anemones within and between two nearby reefs to elucidate their reproductive mode and dispersal potential. We sampled two species (*Stichodactyla gigantea* and*Heteractis magnifica*) almost exhaustively at Tuare and Kimbe Island in Kimbe Bay, Papua New Guinea, which are separated by approximately 25 km. Panels of microsatellite markers were used to study the reproductive mode and population structure of these species. Surprisingly, genetic analyses confirmed six pairs of clones for *S. gigantea* (n=350), indicating the first record of asexual reproduction for this species; while no clones were found for *H. magnifica* (n=128), which is known to use longitudinal fission as a reproductive mode in other locations. Our results show the first genetic evidence of their reproductive characteristics, high levels of connectivity among islands and significant levels of genetic relatedness among individuals within islands.

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CORAL REEF HEALTH MONITORING BY COMMUNITY VOLUNTEERS AT WAR IN THE PACIFIC NATIONAL HISTORICAL PARK, GUAM (Abstract ID: 28279 | Poster ID: 729)

As a way of bridging the gap between policy makers, scientists, and stakeholders, the War in the Pacific National Historical Park on Guam is undertaking several reef-related citizen science projects. Citizen science is a remarkably successful tool; it fulfills the needs of policy makers, it helps stakeholder participants learn about the organisms and environment they are monitoring, and it develops strong partnerships between the parties involved. At the National Park citizen scientists are taking to the ocean to conduct quarterly coral reef and giant clam (Tridacna spp.) monitoring. By using standardized methods (Coral Watch, http://www.coralwatch.org) to collect large quantities of data from multiple habitats and locations over long periods of time, these citizen science programs will supply much needed information to Guam’s policy makers, scientists, and coral reef stakeholders. With the basic – but integrally important – data, these parties can make educated decisions on how to regulate, recover, and protect some of the island’s most valuable resources.

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NO REEF LEFT BEHIND: USING AND INTERPRETING NOAA CORAL REEF WATCH’S 5-KM REGIONAL VIRTUAL STATIONS FOR MONITORING BLEACHING STRESS (Abstract ID: 28366 | Poster ID: 615)

The National Oceanic and Atmospheric Administration’s (NOAA) Coral Reef Watch (CRW) program has developed a set of Regional Virtual Stations (RVS) that provide comprehensive, localized summaries of bleaching thermal stress conditions for all reef locations worldwide. The RVS bring together CRW’s daily 5-km satellite-monitored and 50-km climate-model projected sea surface temperature products to track environmental conditions in near-real-time and provide bleaching outlooks up to 12 weeks out. There are currently 211 RVS, each of which provides regionally representative statistics based on all satellite data pixels contained within the defined area. RVS locations were created based on political/jurisdictional boundaries; they use global coral reef locations from sources including the Millennium Coral Reef Mapping Project, the World Atlas of Coral Reefs, and other in-house sources. Reef-containing 5-km satellite pixels were identified and augmented with a 20-km buffer around each pixel to define the extent for each RVS. The RVS are used in a series of products including Regional Bleaching Thermal Stress Gauges; the new Satellite Bleaching Alert email system; time series graphs; interactive Google Maps and Google Earth interfaces; and associated data files. These products are

designed to alert reef managers and other stakeholders to changes and potential environmental threats to reefs of interest and help facilitate effective management actions in preparation for and response to mass coral bleaching. This poster details each product's methods and how to interpret the data.
http://coralreefwatch.noaa.gov/vs/index.php

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SPECIES DELIMITATION AND CLUSTERING METHODS HELP IN REVEALING CRYPTIC DIVERSITY IN THE POCILLOPORA CORAL GENUS (Abstract ID: 29285)

The South Western Indian Ocean (SWIO) and the South Western Pacific Ocean (SWPO) are striking marine biodiversity hotspots, showing high levels of cryptic diversity. We focused on one of the major constituents of the Indo-Pacific reefs, the coral genus Pocillopora, using genetic tools to assess species diversity. To do so, 840 colonies from different morphospecies (P. eydouxi, P. verrucosa, P. meandrina and P. damicornis complex) were sampled in both regions. Using species delimitation methods (ABGD, GMYC and PTP) on sequence datasets (ORF, Dloop and ITS2) together with clustering methods (Structure and DAPC) on 10 microsatellites data allowed us unrevealing high cryptic diversity. Indeed, combining the different markers and methods allowed us identifying several putative species: (1) P. meandrina-like colonies from West Madagascar and New Caledonia similar to P. sp. type 8 (sensu Pinzon et al 2013) from Pacific, (2) P. verrucosa-like colonies from SWIO similar to P. sp. type 7a from Indian Ocean (sensu Pinzon et al 2013), and (3) P. eydouxi-like colonies with small, neat, uniform and tight verrucae and present in both regions which have not been described yet. Additionally, P. fungiformis-like colonies sequences from SWIO formed a robust clade with P. effusus sequences from Tropical Eastern Pacific , suggesting these two species being synonyms.

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PLASTICITY IN THERMAL TOLERANCE WINDOWS OF EARLY LIFE HISTORY STAGES (Abstract ID: 30066 | Poster ID: 47)

Temperature is a key factor determining the physiology and distribution of marine species. As the rate of global climate change increases, the influence of temperature becomes more relevant; however, its effects can vary across different life-history stages. Benthic marine species with planktonic larvae may experience different thermal environments during development than as adults and, therefore may also exhibit stage-dependent tolerance to thermal stress. Thermal tolerance of early life stages may also differ in its acclimatory capacity. This research aims to compare thermal tolerances of the sea urchin *Tripneustes gratilla*, an ecologically important grazer present on Hawaiian coral reefs, reared at 20C, 25C and 29C. In order to more accurately predict the ecological consequences of climate change, sublethal and lethal effects of temperature will be investigated, including LT50, oxygen consumption, and swimming/clearance rates of larvae. Results from LT50 measurements demonstrate that early life- history stages of this species do not exhibit a difference in their temperature dependent mortality when reared at different temperatures and that they may lack plasticity in this response to thermal stress. These findings provide a method of comparing and highlighting vulnerabilities of *Tripneustes gratilla* larvae by estimating their capacity for acclimation and potential for adaption to future climate change scenarios.

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CORAL REEF GEOMETRY WARS: USING CORAL GEOMETRY TO UNDERSTAND CORAL-ALGAL INTERACTIONS (Abstract ID: 28869)

Corals must defend their perimeters against algae and other benthic organisms. We hypothesized that resources available to defend a coral's perimeter or attack a competitor depends on the surface area of a colony available for nutrient uptake and photosynthesis. To test this hypothesis, two variable chain-link methods were used to measure the perimeter of six coral colonies from the Caribbean island of Curacao. Surface area was calculated using a 3D, overlapping photo method. These values were used to calculate the perimeter to surface area ratio. Visual scoring was then used to determine the percentage of coral perimeter losing to another benthic organisms (i.e. algae overgrowing coral tissue). The perimeter to surface area ratio positively correlated with the percentage of perimeter along which the coral was losing a competitive interaction, suggesting that a large perimeter:area is energetically expensive and may allow algal overgrowth. Coral geometry serves as a visual representation of all factors impacting a coral colony and may have implications for better understanding coral-algal interactions.

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PH HOMEOSTASIS DURING CORAL CALCIFICATION IN A FREE OCEAN $CO_2$ ENRICHMENT (FOCE) EXPERIMENT, HERON ISLAND REEF FLAT, GREAT BARRIER REEF (Abstract ID: 28269)

Understanding the ability of corals to regulate their internal chemistry at the site of calcification is central to predicting how coral reefs will respond to ocean acidification (OA) as atmospheric $pCO_2$ continues to increase. A major concern is how corals will calcify as seawater pH and carbonate saturation levels decline. Some laboratory studies have suggested corals may cease to calcify as $pCO_2$ levels approach ~600ppm. Yet some corals in their natural habitat are exposed to relatively low pH levels on daily to seasonal time scales. Boron isotope analysis, used as a proxy for pH of the calcifying fluid ($pH_{cf}$) during calcification, suggest corals increase $pH_{cf}$ relative to the surrounding seawater. We present boron isotope data from corals (*Porities cylindrica*) grown in situ at Heron Island Reef flat. These corals were subject to the natural pH regime (control) of the reef and an additional lowering of pH (treatment) relative to this natural regime through $CO_2$ injection. This experiment was performed over 6 months using Free Ocean Carbon Enrichment (FOCE) flumes to allow for the natural variability in ambient seawater chemistry. Our findings suggest pH regulation within these corals is stronger than previously thought. These corals appear to maintain elevated $pH_{cf}$ (~8.6) regardless of seawater pH (range ~7.7–8.3) to facilitate calcification. Furthermore, we expand on how our measurements can resolve some of the ambiguity surrounding the interactions of dissolved inorganic carbon (DIC) during the calcification process.

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A NEW IMAGE CLASSIFICATION APPROACH FOR MAPPING CORAL DENSITY IN KUWAIT USING HIGH RESOLUTION SATELLITE IMAGES (Abstract ID: 27845)

This research study,explores the capability of high spatial resolution multispectral (MS) satellite sensors (WorldView-2 (WV-2) and Pleiades-1B) in quantitatively mapping coral density of Kubbar coral reef ecosystem, located in Kuwait's southern waters. The MS imagery of WV-2 and Pleiades-1B were,after geometric and radiometric corrections, subjected to a number of different classification methodologies and approaches; supervised Maximum Likelihood (ML), unsupervised K-mean, Object-Based Image Analysis (OBIA), and a Multiple Linear Regression (MLR) coral density model.The MLR analysis used the dependent variable of coral density percentage from ground truth and independent variables of spectral reflectance in bands 1 through 6 (WV-2) and bands 1 through 3 (Pleiades-1B),depth (as estimated from a surface derived from bathymetric charts) and distance to land or reef unit center. The results showed that coral density maps developed using the MLR coral density model proved to be the most reliable and accurate (overall accuracy of 67% and Kappa statistic of 0.5 for raw WV-2 and overall accuracy of 70% and Kappa statistic of 0.4 for raw Pleiades-1B) amongst all other image classification methodologies and approaches.In addition,the results highlighted some issues attached to implementation of image classification processes when mapping coral density such as: errors attached to geometrical accuracy of collected data from the field, reef heterogeneity,number of classes being used in image classification and the effects of image pre-processing (radiometric corrections) on image data

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WAVELENGTH-SPECIFIC FORWARD MIE SCATTERING BY BRAGG-REFLECTIVE IRIDOCYTES CONTROLS THE INTERNAL PHOTIC ENVIRONMENT IN GIANT CLAMS (Abstract ID: 27848)

A surprising discovery from our lab revealed that brightly reflective iridocytes in the mantles of Tridacnid giant clams scatter solar photons forward more deeply into the

tissue. While intracellular Bragg reflectors produce these cells' colorful back-reflection, forward Mie-scattering actually enhances illumination of the endosymbiotic, microalgae. We used microspectrophotometry to measure the refractive indices and thicknesses of the Bragg lamellae in live iridocytes in situ, and used these parameters to model the optical behavior of the iridocytes with electromagnetic finite difference time domain (FDTD) simulations. The results offer potentially significant new insights for our growing understanding of the physiological, ecological and evolutionary complexities of the symbiotic relationship between giant clams and their endosymbiotic microalgae. Our results confirm that ca. 90% of wavelength-specific solar photons incident on the iridocytes are propagated deeper into the tissue by forward Mie scattering, and quantitatively show how variations in iridocyte ultrastructure generate variations in the internal photic environment in the animal host that might establish optimal habitats for different clades of algae that preferentially utilize different regions of the solar spectrum for photosynthesis. If this should prove to be the case, reflection of a particular color from the mantle iridocytes might provide a convenient diagnostic for recognition of the light environment within a giant clam, and consequently, for the subtype of alga it might harbor and rely upon.

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NUTRITIONAL INTERACTIONS IN LONG-TERM REDUCED PH SUGGEST ACCLIMATION OF ANEMONIA VIRIDIS? (Abstract ID: 28346)

Growing evidence suggests that symbiotic sea anemones will flourish in an acidified ocean. $CO_2$-enrichment has a fertilizing effect on photosynthesis, increasing the passive diffusion of carbon across membranes and thus reducing an organism's reliance on energetically-costly carbon concentrating mechanisms. Here, we used pulse-chase $^{13}C$ labeling in conjunction with TEM and NanoSIMS imaging to examine how long-term acclimation to reduced pH influences carbon uptake, fixation and turnover in both the symbiont and its host. *Anemonia viridis* were collected from two sites (pH 8.1 and 7.4) situated along a naturally-occurring $CO_2$ gradient in Vulcano Island, Italy. The samples were transferred from their respective sites to tanks with $^{13}C$-bicarbonate labeled seawater. After 5 h, some animals were collected while others were transplanted back to their native sites for a chase period, during which samples were collected at 12 and 36 h, respectively. NanoSIMS images of dinoflagellate symbionts from the 5 h timepoint revealed strong $^{13}C$-labeling of the starch sheath surrounding the pyrenoid, starch granules and lipids present in the symbiont. No significant difference in $\delta^{13}C$ was detected in symbionts and the host gastroderm between sites. The rate of carbon turnover however, did differ, with turnover ca. 23 % faster in symbiont and ca. 40 % faster in the host gastroderm in anemones from the low pH site. We will discuss the long-term acclimation in defining an organism's response to ocean acidification.

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FUNCTIONAL MORPHOLOGY OF PARROTFISHES AND BIOEROSION AT THE ABROLHOS BANK (Abstract ID: 27859 | Poster ID: 263)

Parrotfishes (Labridae: Scarini) play key roles in a number of ecological processes in tropical reefs. Species within this group may differ in their feeding morphology and behavior, which directly shape their impact in a given system. The Abrolhos Bank, northeastern Brazil, encompasses the largest coral reef in the South Atlantic, but little is known on parrotfish feeding ecology in this region. We compared the feeding morphology of three abundant parrotfishes and assessed bite and bioerosion rates of the largest species, Scarus trispinosus, which has suffered severe population declines during the last decade. We found marked differences in the premaxilla, dentary and mouth configuration among the studied species, and between life phases of S. trispinosus. Scarus zelindae has the weakest and most mobile jaws and, as juveniles of the other studied species, was classified as a scraper. In contrast, adults of S. trispinosus and S. amplum are excavators, as they possess robust jaws with simple joints. For S. trispinosus, body size and feeding rates were positively related to volume of substratum removed. Large adults of this species removed about 207 cm3 of substratum per day, with bioerosion rates of 75,500 cm3 per year. This study shows clear differences in feeding morphology among parrotfishes in Abrolhos and indicates that, because of its robust jaws and large size, S. trispinosus plays unique roles in this system. Our results are relevant considering the overfishing in these reefs, especially of large herbivore species, which may directly alter the dynamics of Abrolhos.

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A SYNCRETIC VIEW OF TIME; ASSESSING CORAL-REEF ECOSYSTEM TRAJECTORIES TO SUPPORT SOCIAL-ECOLOGICAL RESILIENCE AND ADAPTIVE CAPACITY INTO THE FUTURE (Abstract ID: 28297)

Coral reefs and human communities are tightly coupled, especially in Pacific Islands where human beings have depended on these resources for millennia. Historical reconstructions of marine ecosystems in Hawaii show steep declines in living marine resources since Western contact. Despite this overall downward trend, integrated social and biological data reveal past periods of local recovery in some resources such as reef fish. We examined marine eco-state trajectories of two communities in Hawaii (Haena and Kaupulehu) that are initiating management plans consistent with traditional knowledge. Based on historical reconstructions, current ecological assessments, and vulnerability to projected climate pressures, we present a syncretic (combining many perspectives) approach to support coral reef ecosystem management. Past recovery periods were associated with increased resource protection, and resurgence in traditional management practices. Present resource fish biomass was significantly lower at Kaupulehu (75 %) and Haena (57%) compared to a virtually unfished reference area. To assess fisheries vulnerability to projected climate change, we constructed a reef fish susceptibility index based on fish size and feeding specialization, which indicated that a small percentage (<1%) of adult resource fish biomass was highly vulnerable to habitat loss due to coral mortality. However a much higher proportion (>75%) of the fish assemblages consisted of fishes <20 cm, indicating vulnerability during early life stages and the need for increased fisheries management and habitat protection.

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TRANSCRIPTOME RESPONSE OF SYMBIODINIUM TO PROLONGED THERMAL STRESS (Abstract ID: 27941 | Poster ID: 19)

Endosymbioses between dinoflagellate algae (Symbiodinium sp.) and scleractinian coral species form the foundation of coral reef ecosystems. Coral symbioses are highly susceptible to elevated temperatures, resulting in coral bleaching, where the algal symbiont is released from host cells. This experiment determined the transcriptional response of Symbiodinium to prolonged thermal stress. Cultures were exposed to elevated temperatures (average 31°C) or control conditions (24.5°C) for twenty-eight days. Thermally treated cultures exhibited reduced cell density from day four onwards ($p < 0.001$). Imaging pulse-amplitude modulated fluorometry determined that photosynthetic efficiency was affected in thermally stressed cells with decreased dark-adapted yield of photosystem II on days 14 ($p < 0.05$), 19 ($p < 0.001$) and 28 ($p < 0.001$). Whole transcriptome sequencing of Symbiodinium cells on days 4, 19 and 28 was used to identify differentially expressed genes. A large number of genes (~23,654 genes, FDR < 0.05) with differential expression were detected, further, fold changes across the transcriptome were low with 92.49% at less than 2-fold. Though a large portion of the transcriptome was differentially expressed, only 2,978 (4.3%) transcripts detected were differentially expressed at all three time points. Analysis identified differentially expressed genes involved in metabolism, growth and stress responses. Interestingly, 56 genes encoding light-harvesting proteins were identified. These genes are hypothesised as critical in the cellular response of Symbiodinium to stress events.

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IMPACTS OF BAPTISM DIVING ON A TROPICAL REEF IN SOUTHEASTERN BRAZIL (Abstract ID: 29991 | Poster ID: 452)

Tropical reefs are a popular destination for scuba diving and one of the world's fastest growing recreational sports. Along the year, millions of people practice their first experience with scuba diving through diving baptism, where a professional conduct a non-certified diver. In Brazil, one of the main sites for diving baptism is the Arraial do Cabo Marine Extractive Reserve (ACMER). Approximately 10,000 people practice diving baptism per year. The diving behavior of the instructor and baptized divers were observed inconspicuously in situ during March and April 2015. We classified the interactions according type of interaction (damage or contact) and organism. Eighty-one diving baptisms were observed, with an average duration of 25 minutes. We verified an interaction overall rate of 0.61 ±0.04 (±SE) touches and 0.15 ±0.02 damages per minute of baptized diver and benthic organisms, mainly gorgonians. The highest rates of touches (1.4 ±0.09) and damages (0.33 ±0.02) occurred when the instructor positioned the baptized diver closely the benthic organisms to take a photo. In this moment, several contacts with benthic organism occurred, but were ignored by instructors. This is a prob-

lem because the high rates of baptism diving in the ACMER can represent a high rate of impacts to benthic organisms. ACMER managers urgently need to implement strategies to eliminate interactions with benthic organisms during baptisms, such as specific sites to take photos, with no occurrence of fragile benthic organisms.

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QUANTIFYING AND OPTIMISING MANAGEMENT OUTCOMES FOR INSHORE REEFS (Abstract ID: 28227)

Prioritising interventions for both land (e.g. sedimentation) and sea-based (e.g. overharvesting) impacts is vital for coastal systems, as the capacity for management authorities to fully address all impacts is often limited. However, prioritisation steps are yet to be completed for many ecosystems, especially those that experience a higher influence of land-based impacts. We use a Bayesian belief network to determine the influence of key management actions for the health of inshore reefs in Moreton Bay, Australia (c. 27°18'S; 153°17'E), a system under threat from multiple anthropogenic influences. Increasing coverage of no-take MPAs by between 50 and 100% and reducing sedimentation by between 25 and 50% were the most important management targets for optimising health of Moreton Bay's reefs. Addressing individual impacts through separate management actions mostly resulted in additive effects for ecosystem health. Importantly, synergistic increases in ecosystem health were not found until the highest actions on sedimentation and no-take MPAs were implemented. Our results show that addressing key impacts from both land and sea are critical for increasing ecosystem health in nearshore marine environments, meaning that dialogue surrounding focus on either is not appropriate and should rather focus on which impacts are most significant for individual systems. Finally, managers should aim to address key impacts first and should not expect synergistic increases in ecosystem health through multiple, but separate management actions until major impacts are substantially reduced.

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HERMIT CRAB-OCTOPUS INTERACTIONS IN DISTRIBUTING RESOURCES BETWEEN REEF AND TERRESTRIAL SYSTEMS (Abstract ID: 28120 | Poster ID: 295)

Terrestrial hermit crabs using shells get this resource primarily from the marine environment. While it is easy to understand how smaller shells commonly found in the shallow back reef might be transported to the terrestrial environment through storm and wave movement, it is unclear how larger shells from gastropods found in deeper reef areas might be obtained in the terrestrial environment. Earlier studies documented that octopuses are important in providing shells for hermit crabs in shallow reef environments of Cayos Cochinos, Honduras. Octopuses range from the shallow intertidal to the outer reef when foraging. Though they consume prey while foraging, they also return to dens with prey, discarding remains into nearby middens. Cumulative data over a ten year study period show that shells of large gastropods are discarded by octopuses near dens in shallow intertidal areas. Distribution of such shells among terrestrial and marine hermit crabs suggests that octopuses are important in moving these resources across the reef. Some shells become incorporated into the reef structure and encrusted by organisms such as poriferans, cnidarians, crustaceans, and algae or may be buried by sediment. Hermit crabs attracted to middens by visual or chemical signals may remove shells from middens as well. Larger shells in shallow middens were exposed at very low tides or during storms, making them accessible to terrestrial hermit crabs. The octopuses are critical intermediaries in this transport system. This research was made possible through permission of the Honduran government.

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LINKING GOVERNANCE TO ECOLOGICAL OUTCOMES IN CORAL REEF MPAS GLOBALLY (Abstract ID: 29787)

Marine Protected Areas (MPAs) are increasingly being employed as a tool to promote biodiversity conservation and maintain flows of ecosystem goods and services to coastal communities; however, their implementation has had varying levels of success. Results from numerous case studies suggest that protected area governance is a major factor in explaining the variation in ecological outcomes, but few studies have been able to examine the linkages between MPA governance and reef fish impacts at a regional or global scale. As part of a global study, we compiled ecological data from over 13,000 underwater reef surveys and governance data from approximately 350 management assessments to explore the relationship between MPA governance and ecological outcomes in reef fish populations. Using an impact evaluation approach to control for potentially confounding factors, preliminary analyses demonstrate (on average) increases in fish population metrics (e.g. total biomass) within MPA boundaries, particularly within no-take zones. Detailed governance data were available in approximately 50 coral reef MPAs, and preliminary results show significant relationships between responses of fish populations to protection and the presence of specific governance and management attributes (e.g. clearly defined boundaries). This research will provide evidence-based insights into how the ecological impacts of coral reef MPAs are shaped by governance and management conditions, contributing to more informed coral reef management and policy.

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IMAGE MOSAICS BEFORE, DURING, AND AFTER THE 2014 MASS CORAL BLEACHING AT CHEECA ROCKS, FLORIDA KEYS REVEAL HIGH RESILIENCE OF A CARIBBEAN CORAL REEF (Abstract ID: 29758)

Warm-water coral bleaching has been a main driver of reef decline in recent decades. However, little is known about how coral community composition will change with annual bleaching. Underwater photomosaic imaging technology is a rapid in-water survey technology that provides accurate information on coral community composition, coral cover, and individual colony health that can be used over time to answer questions on species susceptibility and mortality due to coral bleaching. In 2012 a long-term monitoring program, part of NOAA's National Coral Reef Monitoring Program (NCRMP), was established at Cheeca Rocks, Florida Keys using photomosaics to map and document the health of 5227 coral colonies representing 21 Caribbean species. Mosaics were collected annually from 2012-2015, with additional sampling in September 2014 and March 2015 to document peak bleaching in 2014 and recovery, respectively. We evaluated coral species' bleaching susceptibility and mortality as a result of the 2014 event. Bleaching incidence was low for *Porites astreoides* and *Siderastrea siderea*, but nearly 100% for *Porites porites* and the threatened coral species*Orbicella annularis*. Despite 2014 being the warmest on record, the coral community at Cheeca Rocks was highly resilient with low partial and total coral mortality. Continued mosaic monitoring during and after the repeat bleaching in 2015 will lead to information on species resistance and resilience under consecutive heat-stress events; a scenario predicted to occur as early as 2020 in the Florida Keys.

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THE ROLE OF SULFATE ON GROWTH RATES AND SKELETAL COMPOSITION OF *POCILLOPORA DAMICORNIS*: INSIGHTS INTO BIOMINERALIZATON IN ANCIENT OCEANS (Abstract ID: 29451 | Poster ID: 98)

The rise and fall of scleractinian coral dominated reefs throughout the Mesozoic and Cenozoic is strongly linked to changes in the chemistry of seawater (calcite vs aragonite seas). Changes in the ion chemistry of seawater have profound effects on the dominant

reef builders in ancient oceans and the biomineralization process. Calcite is precipitated in low Mg/Ca seawater, while aragonite is precipitated in high Mg/Ca seawater but other ions (ie. sulfate) may inhibit the precipitation of these minerals. In order to understand the combined effect of both seawater Mg/Ca ratios and sulfate concentrations on coral growth and skeletal composition, we conducted a series of experiments, with *Pocillopora damicornis*, to manipulate the Mg/Ca ratio and sulfate concentration of seawater. Element ratios were quantified to understand the coral calcification under ancient ocean conditions. All coral fragments produced a substantial amount of new growth over the 8 weeks of our experiment; calcification rates increased with increasing seawater Mg/Ca ratios, while treatments with reduced sulfate concentrations grew slower than our control treatments. Preliminary data indicate that skeletal S/Ca ratios are inversely related to seawater Mg/Ca. Skeletal S/Ca ratios also increase with additions of Ca, suggesting that S is not incorporated into skeletons relative to Ca and rather the sulfate anion may be substituted for carbonate in the crystal lattice. Similar mechanisms may also operate on other anions present in coral skeletons and these processes may be rate dependent.

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RISING SEA LEVEL AND REEF RESPONSE IN BORA BORA, SOCIETY ISLANDS, SOUTH PACIFIC (FRENCH POLYNESIA) (Abstract ID: 28050)

Sea-level rise was crucial for Holocene fringing and barrier reef development in Bora Bora, because it created accommodation space and controlled reef architecture. Based on 35 new U-series ages from corals obtained from six rotary cores, early-mid Holocene sea level rose with rates of ca. 5 m/kyr and reached modern level some 6 kyr BP. This level was subsequently exceeded by at least 1 m and eventually approached present level. Occurrence and distribution of coral assemblages indicate an upcore increase in wave energy. Age-depth plots further suggest that fringing and barrier reefs have prograded during the mid-late Holocene. The Holocene fringing reef is up to 20 m thick and comprises coralgal and microbial reef sections, and abundant loose sediment, overlying Pleistocene basalt and soil. An Acropora-Montipora assemblage transitions upcore into a Pocillopora assemblage. Fringing reef growth started 8.78±0.05 kyr BP; accretion rates average 6.54 m/kyr. The barrier reef consists of >30 m thick Holocene coralgal and microbial successions, characterized by an upcore transition from an agaricid-rich to a robust-branching Acropora assemblage. Holocene barrier reef growth began 10.03±0.05 kyr BP; accretion rates average 6.15 m/kyr. An underlying Pleistocene barrier reef contains laminar Montipora and agaricids, and formed 116.93±1.1 kyr BP, i.e., at the end of marine isotope stage 5e, in water at least 20 m deep.

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SHORT-TERM EXPOSURE AT $CO_2$ VENT AFFECT SPERMATOGENESIS IN A TEMPERATE NON-ZOOXANTHELLATE CORAL (Abstract ID: 29470)

Ocean acidification is expected to significantly affect calcifying marine organisms, such as corals. While ocean acidification effects on coral calcification have been widely investigated, the effects on coral gametogenesis are almost unknown. A volcanic vent at Panarea Island (Mediterranean Sea, Italy) characterized by continuous and localized $CO_2$ emission, generates a stable $pCO_2$ gradient from the centre to its periphery, providing a unique natural laboratory for ocean acidification studies. Here we assessed the effects of ocean acidification on gametogenesis and embryogenesis of the Mediterranean non-zooxanthellate coral *Leptopsammia pruvoti* transplanted along this natural $pCO_2$ gradient. After 3 months under experimental conditions, increasing $pCO_2$ seemed to negatively influence spermary production and development. In the control Site, all spermaries showed the latest (most advanced) maturation stage while in the most acidic Sites they also displayed earlier stages, indicating a delay in spermatogenesis and consequently of fertilization and planulation processes. Considering the negative response showed by this species after a short-term exposure, an even stronger negative effect on sexual reproduction is hypothesized under a long-term exposure.

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COMPARISON OF PRESENT DAY CORAL REEF DISTRIBUTION WITH THE EXPOSED HOLOCENE REEF IN RAMESHWARAM ISLAND, GULF OF MANNAR, INDIA – INFERENCE FOR PALEOECOLOGY (Abstract ID: 29236 | Poster ID: 231)

The Rameswaram Island in Gulf of Mannar forms the southernmost extension of the Cauvery basin, India. Carbonate and clastic rocks of Holocene were observed exposed as cliff/terraces along the shores of northeast to northwest and central part of this Island. The uplifted terraces display well preserved coral reef and associated facies indicating the paleoecology and sea level. Totally 25 rock samples collected from eight locations were studied for petrographic, geochemical and isotropic characters. Three types of facies such as lithified beach rock (older), constructed reef facies and lithified beach rock (younger) facies were identified in the exposed cliff. Few regions are dominated by branching and table growth forms (Acropora), which indicate the shallow facies with low energy, whereas most of the region is dominated by boulders (Porites and Favites), which indicate deeper facies with high energy than branching type. The exposed reef shows a complex diagenetic history, which certainly implies the flooding and exposure phases the reef system went through as well as climate changes. Current distribution of corals was assessed with line intercept transects in the near-shore region of the exposed reefs and it is understood that the study region is dominated by boulders and very few patches of acroporids. The study provides evidence that there is a change in ecology from Holocene to present day. The assemblage of corals, algae, bryozoans, echinoids and benthic foraminifera point towards an inner neritic depositional environment for the raised reef during deposition.

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BIGGER IS BETTER: UNDERWATER IMAGE MOSAICS OF LARGE AREAS FOR IMPROVED CORAL REEF MONITORING AND ASSESSMENT (Abstract ID: 29771)

An underwater image mosaic is a high-resolution single-image map of an area of interest created through the alignment and blending of downward-looking component images. Underwater image mosaic surveys retain the speed, detail, and measurement accuracy associated with diver-based coral reef surveys while providing a superior archival tool for documenting benthic changes over time. As a result, underwater image mosaics have become a valuable tool for documenting marine resources as part of both traditional monitoring programs and damage assessments intended for mitigation. Recent technological advances, such as inexpensive high-resolution underwater cameras and low-cost computing have increased both the speed and size of benthic surveys that can be imaged without the use of complex underwater robotics. As a result, underwater image mosaics have recently been used to survey over 50,000 m2 of reef around a ship grounding, rapidly acquire 500 m2 of imagery in a single dive, and document large-scale reef restoration success. The ability to rapidly obtain high-resolution benthic information over large areas makes image mosaics a powerful tool for monitoring and assessing damage when both biological information and accurate size estimates are essential for assessing and restoring reef resources.
http://yyy.rsmas.miami.edu/groups/reidlab/

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VARIABILITY IN CORAL RECRUITMENT ALONG THE FLORIDA REEF TRACT (Abstract ID: 29685)

Reef resilience to global climate change is enhanced when coral recruitment rates exceed mortality rates. Along the Florida Reef Tract (FRT), USA, there is consensus that recruitment failure is impeding coral recovery, but the temporal and spatial variability in this parameter is unknown. We are quantifying interannual variation in scleractinian and octocoral recruitment to 15x15 cm terracotta tiles and natural substrata across much of the FRT. A total of 30 long-term stations (18 in Florida Keys, 12 in southeast Florida) employed by the Coral Reef Evaluation and Monitoring Project were selected, thus allowing comparative analysis of the role that extant biological communities and water temperatures play in coral recruitment processes. Young coral recruits (<3 months old) are often difficult to identify to the species level, so a further transformative aspect of this project is development of a PCR-based system that incorporates species-specific molecular markers to identify recruits. To date we have deployed 32 tile pairs at each site, a total

of 1,920 tiles. A preliminary analysis of a subset of tiles indicates low recruitment rates, 0.2 recruits per tile, consisting exclusively of brooding coral species. Development of the molecular markers is well underway for 16 coral species and shows promise as a tool for verifying recruit identity. In sum, this study is informing management efforts within the FRT by identifying recruitment hotspots, as well as those sites and species having limited ability to counter climate change stressors through natural recruitment processes.

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BEYOND ECOSYSTEM SERVICES: EMPIRICAL EVIDENCE OF THE CAUSAL MECHANISMS LINKING MARINE PROTECTED AREAS AND HUMAN WELL-BEING FROM PAPUA, INDONESIA (Abstract ID: 29711)

Recent conservation policy and practice has emphasized the central role of ecosystem services in shaping human well-being. For example, marine protected area (MPA) narratives are dominated by the role of protection in enhancing food security and incomes through increased fish biomass. But, ecosystem services do not represent the only pathway linking conservation and human well-being. Scholars have long recognized the potential for impacts to emerge from the restructuring of resource rights and the infrastructure linked to conservation interventions, as alternative pathways by which conservation efforts may affect local communities. We present empirical evidence of the multiple pathways linking the establishment of MPAs to human well-being in coral reef ecosytems. Drawing on a quasi-experimental impact evaluation of six MPAs in the Bird's Head Seascape, Indonesia, we examine five distinct pathways by which MPAs affect human well-being, including ecosystem services, property rights reallocation, MPA management infrastructure and ancillary opportunities. Structural equation modeling reveals the existence of multiple pathways, initiated by MPA establishment that generate an array of short-term social impacts. We examine the synergies and trade-offs among pathways, as well as the relative importance of unintended pathways. In so doing, we illustrate the incentives, and constraints to the long-term sustainability of MPAs, highlighting the need for a more nuanced understanding of conservation-poverty relationships as the basis for more effective policy and practice.

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INSIGHTS ON THE PERSISTENCE OF THE WELLINGTON REEF IN THE NORTHERN GALAPAGOS ISLANDS: A MODELING PERSPECTIVE (Abstract ID: 27832)

Wellington Reef is the largest known structural reef in the Galápagos Islands. This study explores the recovery potential of the Wellington Reef using a stochastic simulation that employs empirical data on coral growth, bioerosion, fecundity, recruitment, bleaching and mortality from the Wellington Reef and nearby sites. A probabilistic model was developed to estimate $CaCO_3$ erosion of individual coral colonies by the sea urchin *Eucidaris galapagensis*. The daily mobility behavior of *Eucidaris* was approximated using empirical observations obtained from other sea urchin species demonstrating similar foraging behavior. A non-central chi-squared distribution provided the foundation for modeling the expected number of *Eucidaris* visits a coral colony may experience. Numerous projections 50 years into the future were performed utilizing sea urchin density distributions ranging from very low to very high obtained from local surveys. We subjected each projection to El Niño event schedules that offer plausible future oceanographic disturbances based on recent historical event frequencies. We evaluated the survivability of the Wellington reef by analyzing the net $CaCO_3$ production on an annual basis over a 50-year projection period. Moderate levels of sea urchin densities above current very low densities may significantly increase the likelihood of collapse of the Wellington Reef.

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CORAL REEF ECHIURANS: AN UNDERSTUDIED CRYPTIC FAUNA (Abstract ID: 27821)

Recent sampling of the cryptic fauna of a pocilloporid patch reef in Panama has revealed high abundances of an undescribed species of the echiuran *Analassorhynchus* sp. This species is relatively small (2-4 cm) and secretive, inhabiting fine sand/silt sediments beneath coral rubble and simulated frameworks. The guts of all examined specimens were packed with sand grains, shell fragments, and particulate organic matter, evidence of deposit feeding and a potentially important contribution to nutrient recycling. The occurrence of *Analassorhynchus* sp. in the deep recesses of carbonate structures would allow it access to entrapped fine sediments not easily reached by large deposit feeders. Quantitative sampling along the Uva Island forereef, from 3 to 6 m depth, revealed median population densities of 1.2 to 7.2 ind per 20 liters of sediment sampled over a four year (2002-2006) period. In terms of reef area sampled, this is equivalent to 4.8 to 28.8 ind per m. These abundances held steady through the wet and dry seasons. Echiurans are presently known to inhabit coral reefs in Australia, Hawaii, and at upwelling and non-upwelling sites in the eastern Pacific. An important role in nutrient recycling is likely to be recognized as studies of this taxon proceed.

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SMALL FISH REVEAL THE BIG PICTURE ON CORAL REEFS (Abstract ID: 28285)

Although Glenn may be better remembered for his work on connectivity and marine reserves, he made great advances in studying the settlement and predation of small fishes on coral reefs. Small fishes play critically important roles in coral reef ecosystems, yet unfortunately for them, reefs represent high risk habitats. Upon settlement, many small fishes face extremely high mortality rates, which can range from 6% to almost 70% per day. Given the danger of being small on a coral reef, it is surprising that such a large number of fishes such as gobies and blennies stay small throughout their lives. In this presentation I will consider small fishes, whether juveniles or adults; introduce what is currently known about their important functional roles on coral reefs, then present results from a series of recent studies that offer insights into the dynamic nature of small fish communities. I will demonstrate how the short lifespans, fine niche-partitioning and high mortality rates of small fishes result in diverse and highly structured assemblages that anchor many trophic pathways and may prove to be sensitive indicators of environmental change. I will also highlight a previously overlooked role of small fishes as predators on coral reefs. These recent findings suggest that the high mortality rates observed in small fishes may be a result of feeding by overlooked cryptic predators. Indeed, some of these small fishes may be the most important predators on coral reefs.

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BIOCHEMICAL AND BACTERIAL COMMUNITY CHANGES DURING THE COURSE OF PATHOGENESIS IN THE SPONGE DISEASE APLYSINA RED BAND SYNDROME (Abstract ID: 28441)

Sponges are essential ecological components of coral reefs, and like corals, sponge diseases have been reported with increasing frequency worldwide. Aplysina Red Band Syndrome (ARBS) is widespread across the Caribbean basin, affecting up to 10% of Aplysina cauliformis, one of the most common members of the Caribbean sponge community. ARBS significantly impacts sponge physiology and, ultimately, sponge growth, survival and population dynamics. ARBS is highly transmissible via sponge-to-sponge contact, enabling us to identify biochemical and bacterial community changes in sponges over the course of pathogenesis. We performed 9-day contact experiments with healthy-diseased and healthy-healthy control treatments in the Bahamas in January and July. We compared individual sponges sampled initially and at successive time points to characterize short-term temporal changes in concentrations of chlorophyll a (associated with the loss of cyanobacterial symbionts), total protein, secondary metabolites, and heat shock protein, as well as bacterial assemblages. All healthy sponges in contact with diseased sponges developed ARBS by day 9 and observed changes correspond with the timing of ARBS development. Several biochemical markers, and bacterial assemblages, of initially healthy sponges that developed ARBS during the experiment shifted towards those of naturally diseased sponges over this time period. This represents one of few studies to evaluate temporal changes over the course of pathogenesis in a marine invertebrate.

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CHARACTERIZING PARTICIPATION IN NON-COMMERCIAL FISHING AND OTHER SHORE-BASED RECREATIONAL ACTIVITIES ON ST. CROIX, USVI (Abstract ID: 29572 | Poster ID: 598)

Fishing is part of the culture and heritage of the U.S. Virgin Islands (USVI). Residents of USVI fish for enjoyment, to gather food, to bond with others, as well as for gifting and other traditional activities. From December 2013 - October 2014, researchers walked the shores of St. Croix to gather information on shore-based fishing and other recreational activities. A primary goal for this study was to assess fishing effort for non-commercial fishing conducted from shore, as well as to document levels of participation in other

shore-based activities. The study found that the number of fishers using the shoreline at any given time during the study was relatively low compared with people engaged in other recreational activities. However, findings indicate that particular areas, times of day, and days of the week were more popular with shore-based fishers than others. Observing, walking, swimming, sunbathing, camping and snorkeling were the most common non-fishing activities documented during the study period. Shoreline areas near population centers exhibited higher numbers of people engaged in recreational activities than more remote areas of the island. The study found that shore-based, non-commercial fishing on St. Croix was not as commonplace as expected, but that the shoreline is important to the community for a variety of other recreational activities.

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A COMPARISON OF DISEASE PREVALENCE IN WILD AND OUTPLANTED*ACROPORA CERVICORNIS* COLONIES ALONG THE FLORIDA REEF TRACT (Abstract ID: 29027)

As coral restoration projects become more common there are important ecological questions to be addressed, such as the health of outplanted corals in relation to the natural reef community. Here we examined data from multiple projects to make preliminary comparisons of disease prevalence in wild and outplanted *Acropora cervicornis* colonies. Data were gathered from a large *A. cervicornis* demographic monitoring project covering three Florida regions: Broward County (BWD), Middle Keys (MDK) and Dry Tortugas (DRTO) and multiple outplanting projects within BWD. Prevalence of disease was calculated for every monitoring event (annual to monthly) between 2010 and 2015 for each region and all outplant projects. The overall mean colony prevalence of disease per event, all projects combined, was 3.4%. Disease was most prevalent during summer months for wild and outplanted populations. MDK wild colonies had the highest mean prevalence of disease per monitoring event, whereas outplanted colonies had the lowest mean prevalence of disease per event. The highest prevalence of disease for any one event was recorded on wild colonies in BWD during the Summer 2015 at 18.5%. These data indicate that the prevalence of disease in outplanted corals across multiple years and during outbreak events is similar to, if not less than, that recorded across the entire Florida Reef Tract for wild colonies. These data also provide further evidence that outplanted corals respond to stressors similar to wild colonies and currently are not a significant health risk to wild coral populations.

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OPTIMIZING OUTPLANT SUCCESS FOR *ACROPORA CERVICORNIS*: AN ASSESSMENT OF VARYING COLONY DENSITY, SIZE AND ATTACHMENT TECHNIQUES (Abstract ID: 28404)

The most widely used coral species in the greater Caribbean for reef restoration is Acropora cervicornis. However, best outplant methodologies in terms of colony density, size and attachment technique have not yet been adequately evaluated. Two studies were developed to evaluate A. cervicornis outplanting methodologies in southeast Florida. In the first study, colonies 10-15 cm total linear extension(TLE) were outplanted using a nail, epoxy and cable tie at densities of 1, 4 or 25 corals per 2 $m^2$ plot, each density was replicated 12 times. Colonies outplanted in the second study were of small (5-10 cm TLE), medium (11-30) or large (31-50) size class and outplanted using nail and cable tie, epoxy or cement puck. Each size class was replicated 45 times per attachment technique. In the first study, survival after 2 years was highest for corals outplanted at 1 coral per 2 $m^2$ and lowest for corals outplanted at 25 corals per 2 $m^2$. The number of colonies missing and overall prevalence of disease and predation was greatest in high density plots. In the second study (9 months), corals attached using a nail and cable tie, regardless of size, was the most successful in terms of survival. Large corals had the highest rate of survival over small and medium corals. A majority of coral loss was attributed to missing corals, which was highest for the puck technique and also small epoxied corals. These results indicate that greatest outplant success may be achieved by using a nail and cable tie to attach larger colonies at a minimum spacing of 2 m.

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PERIODICALLY HARVESTED CLOSURES PROVIDE SHORT-TERM FISHERIES BENEFITS (Abstract ID: 28424)

Periodically harvested closures (PHCs) are small fisheries closures that range from being mostly closed to mostly open to fishing. We provide the first comprehensive assessment of PHCs to provide short-term fisheries benefits across Fiji and the broader Western Pacific. PHCs in Fiji consistently decreased the wariness of larger targeted fish species, but were less likely to increase abundance or biomass. PHCs in the Western Pacific had a 48% greater abundance and 92% greater biomass of targeted species when compared with areas open to fishing, suggesting they are capable of providing short-term protection benefits. Harvesting PHCs results in a rapid increase in wariness and decrease in the abundance and biomass of targeted fishes. Factors affecting the ability of PHCs to provide short-term protection and harvest benefits included size, duration of closure and compliance. Strict controls are needed during openings to optimize future benefits. One year of PHC closure was insufficient for the recovery of pre-harvest protection benefits, which were principally observed for species with low and moderate vulnerabilities to fishing. Despite the ability of PHCs to provide some short-term fisheries benefits, a broader range of fisheries management and conservation strategies are needed for the long term sustainability of small-scale fisheries in the Western Pacific.

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CLIMATE CHANGE, THE GREAT BARRIER REEF, AND THE RESPONSE OF AUSTRALIANS (Abstract ID: 30151 | Poster ID: 600)

Inspiration, aspirations, attitudes, and perception of threats play a pivotal role in the way that individuals associate themselves with natural environments. These sentiments affect how people connect to natural places, including their behaviours, perceived responsibility, and management interventions they support. World Heritage Areas hold an important place in the lives of people who visit, aspire to visit, or derive a sense of security and wellbeing from their existence. Yet, the connection between people and special places is rarely quantified and policymakers find it difficult to incorporate these human dimensions into decision-making processes. Here we describe the personal concern and connection that Australians have with the Great Barrier Reef and discuss how the results may help with management. We utilise a statistically representative sample of Australian residents (n= 2,002) and show empirically that climate change is perceived to be the biggest threat to the Great Barrier Reef, and that the Great Barrier Reef inspires Australians, promotes pride, and instills a sense of individual identity and collective responsibility to protect it. An increased understanding of the high levels of personal connection to iconic natural resources may help managers to enhance public support for protecting climate-sensitive systems within Australia and around the world.

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DETECTING HOURLY TO DAILY VARIABILITY IN SUBMARINE GROUNDWATER PLUMES, NUTRIENTS AND FLUORESCENT DISSOLVED ORGANIC MATTER AT A CORAL REEF IN MAUNALUA BAY, HI (Abstract ID: 29707 | Poster ID: 461)

Submarine groundwater discharge (SGD) can deliver high concentrations of dissolved inorganic nutrients (DIN; N, P, Silicate) to Maunalua Bay, Oahu, Hawaii. Our previous research has demonstrated that fluorescent dissolved organic matter (fDOM) is a useful biogeochemical tracer of SGD, but we know little of how hourly to daily variation in SGD may alter dissolved nutrient distributions across reefs. Here, we present data tracking the temporal and spatial variation in SGD, fDOM and dissolved nutrient distributions over a 9-day period at Black Point, Maunalua Bay. Four coastal ocean sites were sampled over an onshore to offshore spatial gradient: the submarine spring, 2 sites in the transition zone, and a near-reef crest "marine-like" site. Samples were collected for fDOM, radon, temperature, salinity, DIN, dissolved organic carbon and nitrogen (DOC and DON), chlorophyll a, and microbial abundance and diversity. Our results reveal that Black Point SGD has cooler temperatures, lower salinity, and higher radon and dissolved inorganic nutrient concentrations than that of "marine-like" waters. We also observed clear temporal and spatial patterns in the enrichment and decline of SGD and DIN at each site, and were able to resolve significant enrichment at the "marine-like" site. Patterns in fDOM will be discussed as they relate to tracing SGD at each site. These results provide new information on the effects of SGD on coastal coral reef nutrient dynamics over hourly to weekly timescales and as a function of tides and land hydrology.

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REFUGIA AND RESILIENCE: VARIABLE POPULATION DEMOGRAPHICS AND REPRODUCTION OF A CORAL REEF FISH ACROSS VERTICAL SPATIAL SCALES (Abstract ID: 29782)

With the decline of coral reef ecosystems, reef organisms may become dependent upon habitats at the periphery of their distributions for population persistence. Mesophotic coral reefs (30-150 m), near the depth boundary of most reef fishes, may be natural refuges that can supply larvae to degraded reefs, and are buffered from anthropogenic and natural disturbances. However, depth-driven habitat variability can mediate the refuge function of mesophotic reefs by affecting demographic parameters that influence population resilience and connectivity. We compared population density and structure, size, growth, and reproduction of a model reef fish (bicolor damselfish: *Stegastes partitus*) across shallow shelf (<10 m) and deep shelf (20-30 m) reefs in the Florida Keys, and mesophotic reefs (60-70 m) at Pulley Ridge to assess the refuge function of peripheral habitats. As depth increased, populations were comprised of older and larger individuals, and density decreased, suggesting that mesophotic populations are limited by replenishment of young fish. Otolith-derived ages, measurements of oocyte area, and batch fecundity indicated that mesophotic fish reach larger asymptotic sizes, and have longer lifespans and higher reproductive investment than fish in shallower habitats. Reliance on long-lived individuals for population persistence may decrease ecosystem resilience, however, by supporting populations of large, long-lived individuals, mesophotic reefs may be important sources of larvae for shallow fish populations and may function as valuable refuges for future populations.

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BLUE THE DIVE: AN INNOVATIVE PARTNERSHIP BETWEEN THE OCEAN CONSERVATION COMMUNITY AND THE SCUBA INDUSTRY (Abstract ID: 30166 | Poster ID: 637)

SCUBA professionals, scientists, and recreational divers are first-hand witnesses to the destruction of marine and coral habitats, which includes potential adverse impacts from divers themselves. The SCUBA industry is in a position to promote and advance responsible stewardship of the ocean by both changing the way that people interact with their underwater environment and inspiring them to advocate for marine conservation. However, there has been no substantive, effort to organize the dive community. NOAA's National Marine Sanctuary Program began a campaign in 2007 but shelved it because they did not have the backing of the SCUBA industry. In 2013, a new initiative called Blue the Dive (BTD) originated in Boulder, Colorado that aims to create partnerships between the conservation community and the dive industry. The mission of BTD is to promote a strong and unified voice for ocean protection driven by the dive community, improve SCUBA industry sustainability practices, create a more informed and educated consumer, support scientific research, and promote actions that protect the ocean. So far, BTD has organized 3 well-attended symposia at Diving Equipment & Marketing Association (DEMA) meetings (the dive industry's largest trade show), created a BTD social media presence, developed guidelines on "How to be a Blue Diver and Blue Dive Shop", sponsored a BTD Pledge with 2000 signatures, partnered with Blue Certified (an eco-certification program), and filmed messages of support from over 20 industry leaders.

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USE OF ANCIENT DNA TO UNDERSTAND CORAL-MACROALGAE INTERACTIONS AT MILLENNIAL SCALES (Abstract ID: 28969)

Phase shifts and the declining ability of ecosystems to recover from disturbances are now commonplace in marine environments. On the inshore Great Barrier Reef (GBR), coral dominance has shifted from*Acropora* to weedier coral species reducing ecosystem resilience. Phase shifts have also resulted in the replacement of corals by fleshy macro-algae. We conducted a coring program of inner shelf reef sediments along the GBR. Through study of the fossil record within the cores, we found recent unprecedented disruption of millennia-scale dominance of *Acropora*. The timing of these shifts is consistent with degrading water quality associated with European colonization of the adjacent coastline. Using ancient DNA (aDNA), here we test whether shifts in coral community composition were associated with changes in macro-algae abundance. All of the sediment samples studied yielded aDNA across the past 750 years. Multivariate analysis of 12 functional groups showed significant temporal variation in the aDNA community structure of one of the two sites studied. The abundance of brown algae from aDNA was negatively related to the abundance of the most dominant corals for both sites. Our results demonstrate the ability for reef sediments to record environmental aDNA, providing a valuable archive for understanding past distributions and relative abundance of important reef dwellers that do not fossilize. This information can be used to detect temporal trends in the frequency and magnitude of past coral to macro-algae phase shifts over decadal to millennial time scales.

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GENETIC DIVERSITY RELATED TO HABITAT IN THE REEF BUILDING CORAL ACROPORA PALMATA (Abstract ID: 28426)

The critically endangered Acropora palmata plays a unique role throughout the Caribbean region. It has a life history strategy that combines sexual (genet recruitment) and asexual (ramet recruitment) reproduction. The spatial distribution of genets and ramets are expected to change as a function of the frequency with which this species recruits different types of offspring. In this study, 12 A. palmata stands (322 colonies) were randomly sampled on 7 reefs along the Caribbean coast of Mexico. Habitats were identified as high (HWZ) and low (LWZ) wave action zones. Application of microsatellite markers resulted in 297 multilocus genotypes. Estimates of allelic and clonal diversity were calculated, and fine-scale spatial genetic structure (SGS) characterized. Estimates of clonal diversity (richness, diversity and evenness) were significantly higher in HWZ. No SGS was detected when considering each genet once. However, positive SGS was detected in both HWZ and LWZ at the ramet-level, with an estimated clonal range of 27 m and 58 m, respectively. A statistical difference in SGS between habitats was also identified. Estimates of allelic diversity were significantly higher in HWZ, providing further evidence that A. palmata stands from the two habitats are distinct in terms of genetic diversity. We suggest that clonal range is mainly determined by wave action along the Mexican Reef Tract, perhaps due to differential rates of fragmentation and/or due to lower rates of fragment survivorship in high-energy habitats. When restoring reefs with nursery-reared fragments, existing habitat differences in genotypic and genetic diversity should be considered.

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THE 2014-2016 GLOBAL CORAL BLEACHING EVENT: PRELIMINARY COMPARISONS BETWEEN THERMAL STRESS AND BLEACHING TIMING AND INTENSITY (Abstract ID: 28759 | Poster ID: 343)

Rising ocean temperatures have increased the frequency of coral bleaching events. The extremely strong El Niño in 1997/98 triggered bleaching that killed about 16% of the world's coral. In 2010, during a mild El Niño year, elevated ocean temperatures resulted in mass bleaching events in many parts of the world. Currently during another record-strength El Niño event, another global bleaching event has been underway since mid-2014. The National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Watch (CRW) is undertaking an effort to collect and document reports of the severity and extent of the ongoing bleaching event. CRW is collating bleaching data (including reports of no bleaching) from collaborators for the period 2014 through at least 2016. In situ bleaching observations are compared with CRW's satellite measurements of bleaching thermal stress to test CRW's thermal stress monitoring products, including the Coral Bleaching HotSpot and Degree Heating Week products. This presentation explores the timeline of record thermal stress and bleaching occurring globally from 2014-2016 based on the comprehensive in situ bleaching observations CRW has collected to date. Preliminary results from comparisons of bleaching patterns with CRW's satellite products will be discussed for coral reef regions around the globe.

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DESIGNING AN ASIAN MARINE HERITAGE: FISHING FOR PEACE (Abstract ID: 30073)

Establishing a Network of Marine Protected Areas (MPA) in the West Philippine Sea (NeWPS) is a Philippine contribution to the goals of the Coral Triangle Initiative (CTI). Its "Strategic Action Plan," referred to as the Regional Plan of Action (RPOA), proposes to harmonize the multiple uses in this vast marine geographic area for the benefit of future generations. Multilateral efforts to institute a code of conduct, particularly by establishing MPAs, in disputed areas such as the South China Sea have been proposed. However, these have often been suspected as a prelude to other non-negotiable concerns, primarily as regards sovereignty. We explore the scientific tasks, opportunities, and global imperatives in pursuing the functionality of MPA networks for the region. These provide the impetus for scientific collaboration that can pave the way for consensus-building strategies. The basis and design of an MPA network as an Asian Marine Heritage shall emphasize: (i) marine biodiversity conservation, (ii) fisheries resilience through adaptive management, (iii) joint research and monitoring to meet the climate change challenge, and (iv) assured safety of navigation. Design considerations for cooperative arrangements are presented to explain how Science and Technology can Enhance Wise Stewardship and Resiliency of Development Systems. These processes can accelerate the resilience of social-ecological systems, and highlight shared and complementary responsibilities among network partners. Win-win solutions are proposed for these offshore reefs to sustain and move towards inclusive development by parking our differences for this threatened world heritage.

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INDUCTION OF CORAL LARVAL SETTLEMENT BY CRUSTOSE CORALLINE ALGAE (Abstract ID: 27975)

Crustose coralline algae (CCA) are essential for the functioning of coral reefs ecosystems as they create reef structures through calcification, stabilize the reef framework by binding coral rubble, and induce coral recruitment. The presence of CCA is important for settlement of coral larvae, but whether the settlement-inducing compounds are produced by CCA or by their associated bacteria, is still not well understood. We conducted experiments to determine the mechanisms by which CCA induce the settlement of coral larvae, focusing on discerning the contribution of CCA itself and their associated bacteria. We used an orthogonal experimental design with four factors: 1) CCA species, 2) bacteria associated with CCA, 3) allelochemicals produced by CCA, and 4) dissolved organic carbon (DOC) produced by CCA. Equal number of larvae of the coral Acropora millepora was added to each treatment. The results showed that these larvae need environmental cues to settle. Nevertheless, larval settlement can be triggered only by certain CCA and the inductiveness varies among species. The CCA Titanoderma sp. exhibited a striking capacity to induce larval metamorphosis, up to 98%. The CCA allelochemicals were the primary inducers of coral settlement, while the DOC produced by the CCA and the bacteria associated with the CCA tissue played a secondary role in the inductive mechanism. However, the highest settlement rate was attained due to a synergistic effect between CCA and their associated bacteria. Thereby, my research identified key mechanisms driving coral larval settlement.

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ORIGIN AND DEVELOPMENT OF THE DONGSHA ISLAND, SOUTH CHINA SEA IN THE HOLOCENE (Abstract ID: 28145 | Poster ID: 397)

The Dongsha Island is the only island of Dongsha Atoll in the north of South China Sea. The atoll stands about 300-400 meters above sea floor with a diameter of 25 km. The water depth in the lagoon is mostly 10-15 m, maximum 23 m. The island occurs on the inner (lagoonal side) reef flat between two wide channels on leeward (west) side of the atoll, and measures 2.7 km in length (East-West) and 0.88 km in width. The west tip of the island is 0.7 km away from the atoll margin. To explore the Holocene history of Dongsha Island, this study drilled 4 cores of 20-23.3 m in depth, 3 on the Island and 1 on the reef flat west to the island. Lithocolumns were established, and a total of 16 fossil corals were dated by AMS C-14 or U-Th methods and an E-W profile was reconstructed. The results suggest: (1) the Dongsha Island is a sand cay that formed by detrital deposition entirely with no Holocene coral reef or coral conglomerate underneath; (2) the sand-cay deposition might have started since 8150±130 cal yrBP and continued with sea-level rise; (3) the sand cay built up by aggradation with no sign of progradation; (4) the top of limestone basement under the island descends gradually from 13.6 bmsl at seaward margin to 19.8 m bmsl on the lagoonal side; i.e. the island formed where the water depth was relatively deeper. It is interpreted that the island formed mainly by: (1) deflection of waves from the east by the atoll; (2) tidal currents coming from north and south via the two channels; (3) northeast and southwest monsoons.

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OSTREOBIUM DIVERSITY IN THE SCROLL CORAL, AGARICIA UNDATA, AT MESOPHOTIC CORAL ECOSYSTEMS FROM SAN ANDRES ISLAND, COLOMBIA. (Abstract ID: 29594 | Poster ID: 130)

Endolithic algae have important functions in reef ecosystems and will have a critical role in how coral tolerate climate change and ocean acidification. Endolithic algal filaments dissolve $CaCO_3$ crystals making reefs more susceptible to abrasion and dissolution and serve as food for bioeroders. These algae can also facilitate coral survival during bleaching events extending their survivorship without zooxanthellae. In the Caribbean, members of the family Agariciidae are commonly the dominant species in the deeper portions of coral reefs. Agaricia undata, inhabits deep reefs between 15 and about 90 m; this coral is associated with dinoflagellates of the genus Symbiodinium as well as endolithic algae (Ostreobium quekettii). A high abundance of Ostreobium sp. has been observed as depth increases. We took images of the Ostreobium and A. undata using light microscopy and SEM and we found a longitudinal growth and high density of the algae. Using the molecular marker rcbL, we examined the diversity of Ostreobium within A. undata from mesophotic coral ecosystems of San Andrés Island in Colombia to test if depth has an effect on Ostreobium composition. We identified five Ostreobium clades, but did not identify a depth-associated pattern. We have yet to determine if the different clades found in A. undata have an ecological significance. The genotypic diversity of Ostreobium, allows us to speculate that these algae could be physiologically diverse and have developed different adaptations that facilitate photosynthesis in low light environments

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LOCAL VS GLOBAL STRESSORS: THE CASE OF CUBAN CORAL REEF (Abstract ID: 28087)

Coral reef studies from four regions of Cuba carried out between 2001 and 2014 were compiled to assess influence of local stressors versus global ones. Regions studied were Los Colorados archipelago (northwestern), Sabana – Camagüey archipelago (northeastern), Punta Francés (southwestern) and Jardines de la Reina (southeastern). Fishes (density and biomass) and stony corals (density, sizes, diseases and recruitment) were assessed in the four region using underwater visual censuses. The result were compared taking into account fishing pressure, law enforcement, pollution, sedimentation, sea temperature, frequency and strength of hurricanes, information gathered from several sources. Fish density and biomass, in general, were higher where fishing pressure was lower and where law enforcement was stronger. Large, endangered and top predator fishes were more abundant and larger in well-enforced protected areas than outside them. Jardines de la Reina Marine Reserve showed the best fish condition among the four region. Stony corals condition, in general, was better where pollution and sedimentation were lower, with diverse response to increase sea temperature and frequency and strength of hurricane. The fact that most affectations to stony coral were bleaching and ancient mortality is an indicator of a better condition of Cuban corals when compared to Caribbean and world ones. No consistent regional pattern was observed on stony coral among the four regions studied. These results support the hypothesis that Cuban coral reefs condition was more related to local stressors than to global ones.

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MUESO SUBACUATICO DE ARTE (MUSA) AN EFFECTIVE PROJECT TO REDIRECT AND CONTROL VISITORS IN THE NATIONAL PARK OF CANCUN – ISLA MUJERES, MEXICO. (Abstract ID: 29444 | Poster ID: 604)

Protected areas management requieres the use of new ideas to provide effective conservation mechanisms. In Mexico, the use of Carrying capacities or Limits of aceptable change are, by law, mechanisms to incorporate in the management Programs in order to

control the number of visitors but these are diffcult to implement. In the National Park of Cancun Isla Mujeres, aproximately 700 thousand tourist visit this protected area of which 196 thousand (28%) scuba dive in the different coral reef formations. Between 2004 and 2005 coral reef coverage was severly reduced due to three hurricanes of which one was Category 5. Reef restoration Projects were implemented. However, it was decided that a Project redirecting tourist away from coral formations should be designed. The Project commenced with artifical hábitats. In 2008 the implementation of an uderwater Art Museum began to be designed. In 2009 first sculptures were installed and by 2015 more than 520 sculptures have been deployed. MUSA as it is now known has been very succesful. The redirection effect has been assessed and in only one coral reef formation close to 32 thousand tanks are now being used in one of the MUSA galleries. The Project has increased the income of small and large permissionaires and is raising contributions from visitors to increase and maintain the number of sculptures. Though controversial, this Project is now being seen as one great idea to be used in the management of areas with great numbers of visitors.
http://www.conanp.gob.mx

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HOLOBIONT PHYSIOLOGICAL ADJUSTMENTS OF THE CORAL ORBICELLA FAVEOLATA ALONG A LARGE DEPTH GRADIENT (Abstract ID: 29642)

Light is the primary factor controlling coral photosynthesis rates and, consequently, CaCO3 production. The vertical species distribution of Scleractinian corals is directly related to the attenuation coefficient of light (Kd), which also modulates holobiont acclimation to the exponential loss of light intensity with depth. Little research has been conducted to understand the key physiological adjustments behind the plasticity inherent to species able to colonize large depth gradients, in addition to their documented morphological depth-related changes. The progressive increase in tissue pigmentation with depth allows maximizing solar energy collection, but has a structural limit related to tissue self-shading. This structural constraint could be central to determine Symbiodinium photosynthesis, and thus, holobiont capacity to maintain positive carbon balances under light limiting conditions. Here we present an analysis of the variation of holobiont photophysiology along a large depth-gradient (from 5 to 40 m, Akumal, Mexican Caribbean), for a very plastic coral species, Orbicella faveolata. We examined the variation in holobiont photosynthesis and pigmentation, and the effect of depth on the photosynthetic and light absorption efficiencies of the holobiont. We also determined the functional traits that allowed the holobiont to achieve positive carbon balances with depth, and, therefore, are central to maintain coral growth under light limitation.

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PARTITIONING THE EFFECTS OF STRUCTURAL COMPLEXITY ON THE INTRA-HABITAT DISTRIBUTION OF CORAL REEF FISHES (Abstract ID: 28885)

Structural complexity is strongly linked to biodiversity and functioning throughout a number of systems. On coral reefs, the abundance and diversity of fish are often associated with habitat structure. This complexity is typically measured using a single, small-scale metric ('rugosity') that comprises of multiple components, each of which may affect fishes differently and limits our understanding of how fishes associate with reef structure. Recent developments in photogrammetry offer the potential to efficiently study reef complexity in greater detail, leading to measures of different aspects of complexity at multiple spatial scales. Here we assess the use of this technology and multiple components of complexity to explain the abundance of reef fish when compared against traditional metrics of structural complexity. Three damselfish fish species were chosen as model species, based on contrasting trophic habits and expected use of reef structure. 3D reef reconstructions were used to quantify the following complexity metrics: 1) exposure to predators and competitors (field of view), 2) density of predation refuges (crevices) and 3) food availability. Overall, these metrics explain the distribution of fish species between 4 and 400-fold better (40-97% of the variance) than the traditional measure of rugosity, and provide insights into which aspects of complexity are most important. Applying these technologies clearly improved on traditional approaches, while providing new insights into species associations with reef structure and the implications of flattening reefs.

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KI'INA A'O LAWAI'A (Abstract ID: 30143)

This presentation will introduce concepts and traditions of lawai'a (Hawaiian Fishing Practices) which represents an applied pedagogy for marine resource management. The implementation of this cultural practice at the community level is vital to achieving long-term management success. Lawai'a provides a pathway for developing reciprocal relationships between resource users and the natural environment.

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ECOLOGICAL DRIVERS OF LIONFISH AGGREGATIONS ON MESOPHOTIC REEFS IN BERMUDA (Abstract ID: 28391)

Invasive lionfish (*Pterois volitans* and *P. miles*) are now ubiquitous throughout the Caribbean and Western Atlantic, having established themselves in a variety of marine habitats. Recent surveys in Bermuda have revealed dense aggregations of lionfish on mesophotic reefs (60m depth), yet these densities are not pervasive across reefs at this depth. Using diver-led *in situ* surveys of mesophotic reef sites, this study examines how variations in prey fish communities may affect lionfish distribution. A significant correlation was found between prey fish biomass and lionfish density, where sites with a higher biomass of prey fish have higher densities of lionfish. Species-specific correlations of prey fish biomass with lionfish density revealed a significant positive correlation between lionfish density and juvenile *Paranthias furcifer* biomass, however correlations of lionfish density with other prey fish species were not significant. These data indicate that lionfish densities may be driven by distribution and availability of preferred prey types, as gut content analyses show that *P. furcifer* is a preferred prey source for lionfish in Bermuda. Targeted consumption of mesopredators, such as *P. furcifer*, may alter trophic structure affecting the biodiversity of reef communities, however, these data represent baseline assessments of mesophotic fish assemblages, and thus continued monitoring is needed to accurately assess the impacts of these invasive predators.

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POPULATION STRUCTURE OF *MONTASTRAEA CAVERNOSA* ON SHALLOW VERSUS MESOPHOTIC REEFS IN BERMUDA (Abstract ID: 29466 | Poster ID: 332)

Mesophotic coral reef ecosystems remain largely unexplored with only limited information available on taxonomic composition, abundance and distribution. Yet, mesophotic reefs may serve as potential refugia for shallow-water species and thus understanding biodiversity, ecology and connectivity of deep reef communities is integral for resource management and conservation. The Caribbean coral, *Montastraea cavernosa*, is considered a depth generalist and is commonly found at mesophotic depths. We surveyed abundance and size-frequency of *M. cavernosa* populations at six shallow (10m) and six upper mesophotic (45m) sites in Bermuda and found population structure was depth dependent. The mean surface area of colonies at mesophotic sites was significantly smaller than at shallow sites, suggesting that growth rates and maximum colony surface area are limited on mesophotic reefs. Colony density was significantly higher at mesophotic sites, however, resulting in equal contributions to overall percent cover. Size-frequency distributions between shallow and mesophotic sites were also significantly different with populations at mesophotic reefs skewed towards smaller individuals. Overall, the results of this study provide valuable baseline data on population structure, which indicate that the mesophotic reefs of Bermuda support an established population of *M. cavernosa*.

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SOCIAL AND ECOLOGICAL CONSIDERATIONS IN RESOURCE CONSERVATION: GEOSPATIAL PRIORITIZATION FOR SUBSISTENCE FISHERY MANAGEMENT IN SOUTHEAST BRAZIL (Abstract ID: 29546)

The subsistence extractive reserve (Reserva Extrativista - RESEX) of Arraial do Cabo is one of Brazil's first marine extractive reserves, and is setting a precedent for local resource management efforts in areas of complex stakeholder interests. In order to achieve objectives of the reserve and establish an effective management plan, there must be a better understanding of the spatial dynamics of the RESEX area and uses. Here, we aim to 1) identify areas of high user conflict, 2) identify areas of greater ecological value, and 3) make recommendations for spatial fishing regulations that would cause the least conflict among stakeholders and conserve marine resources. This integration of social and ecological information into a Geographical Information System (GIS) is directly applied to local conservation efforts, and intended to enhance the participatory management process as well as provide an adaptive tool for future monitoring efforts. Stakeholder objectives and concerns were gathered from participatory meetings, as was spatial information on the use of the study area. Ecological data of fish distributions and benthic community composition were drawn from surveys carried out over the past two decades. Mapping products contribute to community efforts a better understanding of the spatial reality of stakeholder use and resource distribution. By integrating local user knowledge and scientific data, we provide a visualized evaluation of priority management areas within the reserve, instrumental to a resource management plan that is participatory, adaptive, and effective.

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THE ROLE OF SEDIMENT CHARACTERISTICS IN HERBIVORY DETERRENCE ON CORAL REEFS (Abstract ID: 28551)

Elevated inputs of terrestrial sediments are threatening coral reefs around the globe. These sediment loads contribute to coral reef degradation by reducing the survival of benthic organisms and by changing reef processes. Specifically, sediment loads in the epilithic algal matrix (EAM) deter grazing by herbivorous fishes and may compromise their critical roles on coral reefs. Currently however, the properties of sediments that drive herbivore deterrence are unknown. To understand how sediments inhibit herbivory, it is crucial to disentangle the effects of their various chemical, biological and physical properties. This is particularly important when assessing the specific impacts of terrestrial sediments on inner-shelf reefs. In this presentation I will describe the nature of benthic sediments on inner-shelf reefs of the Great Barrier Reef (GBR) and will discuss their influence on grazing by herbivorous fishes. I will present the results of aquarium based studies which revealed the specific roles of three key sediment attributes: sediment source, grain size and organic load, on grazing by abundant coral reef herbivores. Our findings illustrate the effects that different sediment characteristics may have on herbivory across the GBR. Differences in sediment grain sizes and organic content appear to be crucial drivers of rates of herbivory by grazing herbivores.
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ECOLOGICAL RESTORATION OF DEEP CORAL GARDENS ON THE MEDITERRANEAN CONTINENTAL SHELF (Abstract ID: 27838)

Bottom trawling and trammel net fishing are currently causing the removal or damage of deep-water corals and gorgonians allover the world. Fragmentation and reduction of population density of these structural benthic species is one of the major threats for their viability, and may results in a drastic change in the ecological structural and functional role they play. In this presentation, we show a combination of (1) experimental work under controlled conditions and (2) field research used to perform and evaluate the effectiveness of the first ecological restoration targeted to recover deep gorgonian assemblages on the Mediterranean continental shelf. Laboratory experiments showed that a reduction in gorgonian population density significantly affects their capability to capture food and provide suitable conditions for the aggregation of zooplankton and fish larvae. These results demonstrate how fishing impacts not only affect the gorgonians directly removed or damaged, but also impacts the viability of the remaining populations and their ecological role. Based on experimental results, gorgonians entangled in nets were collected from fishermen, and transplanted at high density on artificial structures, which were deployed on the continental shelf in the north of Cap de Creus (Spain) at 85 m depth. Survival of transplanted gorgonians was monitored during one year by means of a remotely operated vehicle. Zooplankton and sediment samples were also collected to follow the recovering of the biodiversity and biomass of the associated fauna.

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UNDERSTANDING DRIVERS OF HERBIVORE ABUNDANCE TO SUPPORT RESILIENCE-BASED MANAGEMENT IN HAWAII (Abstract ID: 29022 | Poster ID: 714)

For coral reef ecosystems, herbivorous fishes are believed to play a disproportionately large role in ecosystem processes of coral reefs. For example, by controlling algal overgrowth, herbivores contribute to reef resiliency to bleaching events. Herbivorous fish populations are distributed heterogeneously both between and within the Main Hawaiian Islands. While many herbivorous fish species are targeted by fishermen, human-related impacts must be considered alongside locally-varying habitat and oceanographic conditions. We use data on fishing pressure, human population density, oceanographic conditions and benthic habitat, as well as reef fish monitoring data from multiple sources to develop a series of hierarchical Bayesian models that explain spatial variation in herbivore biomass and diversity throughout the state of Hawaii. Results provide a basis for prioritizing areas for herbivore management within Hawaii - e.g. by identifying areas where there is considerable scope for herbivore recovery, and, conversely, where habitat and oceanographic conditions place a low limit on potential herbivore populations. Finally, using a range of estimates of potential trajectories in coral cover and habitat complexity, we estimate how herbivore carrying capacity for Hawaii reefs is likely to change over coming decades.

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IMPACTS OF SEQUENTIAL SUPER TYPHOONS ON CORAL REEF COMMUNITIES AND THE CHARACTERIZATION OF THE RECOVERY POTENTIAL OF CORAL REEFS IN PALAU (Abstract ID: 28569)

Low latitude coral reefs rarely experience typhoons. However, climate change is altering typhoon trajectories. The low latitude reefs of Palau, Micronesia have been unimpacted by typhoon damage for 70 years or more. Yet, in 2012 and 2013, the island was impacted by two successive super-typhoons that catastrophically damaged the eastern outer reefs. Loss of coral cover was highest on the shallow eastern slopes approaching 60%. The density of juvenile corals decreased all around the archipelago, even on reefs where overall coral cover scarcely decreased. These findings suggest a potential stock-recruitment relationship with corals on the damaged eastern reefs. Fish communities were generally unaltered; except small parrotfish which doubled in density along the eastern reef slope and inner reefs following the second typhoon. The long-term recovery of the damaged eastern reefs is unknown. Further research will be conducted throughout 2016 to quantify the recovery potential of Palauan corals reefs, using a combination of historical monitoring data, current assessment of the reef including coral recruitment studies, and modeling techniques. The characterization of the recovery process of the damaged eastern reefs and the drivers that maximize reef recovery will then be adapted into management options.

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CORAL GENETIC DIVERSITY AND DISEASE DYNAMICS (Abstract ID: 28528)

Disease outbreaks have decimated reef-building Acroporid corals in the Caribbean. Recent work has shown that certain Acroporid genotypes appear to be resistant to disease and may thus promote the recovery of these critical coral populations. However, resistant genotypes also appear to grow more slowly than susceptible genotypes. Here,

we use a series of spatially-implicit and spatial-explicit metacommunity models to understand the consequences of this tradeoff between growth and susceptibility on the genetic structure and persistence of coral populations experiencing disease outbreaks. We show that under low disease-induced mortality (i.e., virulence), genetic diversity amplifies the size of disease outbreaks when transmission is high but reduces it when transmission is low. Disease amplification occurs when high transmission and low virulence allow the fixation of susceptible but fast-growing genotypes because infected corals occupy patches for a long time and thus make it harder for resistant but slow-growing genotypes to colonize empty patches. Conversely, disease dilution occurs when low transmission and virulence lead to the fixation of resistant but slow-growing genotypes because there are fewer infected corals and thus more empty patches available for colonization. Overall, these results suggest that understanding these reciprocal feedbacks between coral genetic diversity and disease are critical for devising effective management strategies to ensure the persistence of these important ecosystems.

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HOST FISH ECOLOGY INFLUENCES SYMBIONT POPULATION STRUCTURE AND SPECIFICITY IN A BIOLUMINESCENT SYMBIOSIS (Abstract ID: 28063)

The coral reef-dwelling cardinalfish, *Siphamia tubifer*, forms a specific pairwise symbiosis with the luminous bacterium, *Photobacterium mandapamensis*, harboring the bacteria in a light organ attached to the gut. At night, the fish forages near the reef while emitting bacterial light along its ventrum. The fish returns to a home site at dawn, where it seeks shelter among the spines of sea urchins and releases excess symbiont cells as waste. To examine the role of the ecology of the host in structuring populations of its symbiotic bacteria, we used double-digest restriction site associated sequencing (ddRAD-seq) to define patterns of genomic structure of both the host and symbiont. Analysis of >10,000 single nucleotide polymorphisms (SNPs) in the host fish across 300 individuals from 11 locations in Okinawa, Japan over 3 years yielded low Fst values and no evidence of genetic structure at spatial scales ranging from a few to one hundred kilometers. In contrast, analysis of >600 polymorphic loci in the bacterial genome yielded distinct genetic structure at spatial scales between 40 and 100 kilometers. The lack of population structure in the host fish implies that *S. tubifer* larvae disperse widely as plankton and do not recruit to natal reefs. In contrast, the presence of genetic structure in the symbiont suggests that host larvae acquire their symbiotic bacteria from a locally enriched pool near a settlement site. The site fidelity and homing behavior of the adult fish therefore may shape and maintain symbiont specificity over host generations.

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OCEAN OASES: NEAR-ISLAND BIOLOGICAL HOTSPOTS IN BARREN OCEAN BASINS (Abstract ID: 29755)

Phytoplankton production drives marine ecosystem trophic-structure and global fisheries yields. Phytoplankton biomass is particularly influential near coral reef islands and atolls that span the oligotrophic tropical oceans. The paradoxical enhancement in phytoplankton near an island-reef ecosystem – Island Mass Effect (IME) – was first documented 60 years ago, yet much remains unknown about the prevalence and drivers of this ecologically important phenomenon. Here, we provide the first basin-scale investigation of the IME. We show that the IME is a near-ubiquitous feature among a majority (91%) of coral reef ecosystems surveyed, creating near-island "hotspots" of phytoplankton biomass throughout the upper water-column. Variations in IME strength are governed by key biogeophysical drivers, namely geomorphic type (islands versus atolls), bathymetric slope, reef area, and local human impacts (e.g. human-derived nutrient input). These ocean oases increase nearshore phytoplankton biomass by up to 86% over oceanic conditions, providing basal energetic resources to higher trophic levels that support subsistence-based human populations.

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MOLECULAR AND PHYSIOLOGICAL ACCLIMATISATION REQUIRED FOR CORALS TO THRIVE WITHIN SOUTHERLY HIGH LATITUDE REEFS OF EASTERN AUSTRALIA (Abstract ID: 29779)

Southern high latitude reefs have been considered as potential coral refugia as oceans warm, but in the case of coastal urbanised systems requires that corals have a broad capacity to acclimatise to intense localised anthropogenic pressures. How this can be realised through "genetic reprogramming" (of the coral microbiome and/or coral host) versus physiological plasticity is unknown. We examined how corals have both genetically and physiologically acclimatised to thrive within the Sydney harbour area (~34oS); here, the geographically cosmopolitan Plesiastrea versipora and southerly-restricted Coscinerea mcneilli form relatively large veneering patch communities towards the extremes of their distribution in Australia. Populations were examined across three sites of differing water quality; discrete sampling revealed that Symbiodinium spp. (based on rDNA, microsatellite flanking, and plastid genes) were highly conserved indicating the presence of a single species whereas associated 16S rRNA-based bacterial diversity was highly variable across both host species and with season. Parallel ex situ experiments replicating seasonal conditions examined any differences in metabolic performance (photosynthesis, respiration and calcification) that accompanied the microbiome trends. We show for the first time the molecular and physiological properties required for corals to push their realised niche to southerly extremes.

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FOLLOW THAT FISH: A SUPPLY CHAIN ANALYSIS OF HAWAII'S NEARSHORE FISHERY (Abstract ID: 30040)

Hawaii's coral reef fishery is eclipsed in the economy by the pelagic fishery that generates far more economic value and has been better studied. Data gaps, a lax reporting system in which fishers are required to report what they catch but dealers can voluntarily report what they purchase, backdoor fish sales, and a poor understanding of the total non-commercial catch complicate efforts to monitor this socially, culturally, and economically valuable fishery. In this study, we have traced the supply chain of Hawaii's nearshore fish species (coral reef and reef-associated species) and assessed the economic and social value provided by this fishery. We have utilized commercial catch records for 2009-2013, commercial sales records for the same time period, market price data, and estimations of non-commercial catch for the main Hawaiian Islands. We found that nearly half the fish caught by commercial fishers disappears before commercial sales reports are filed. Non-commercial catch significantly contributes to the supply of coral reef fish, and when the market value is applied, this catch is worth over $7million more than reported commercial sales, indicating that non-commercial fishing provides a significant food expenditure subsidy. The commercial and noncommercial supply provides over 4.3 million meals annually. Coral reef fish are an especially valuable resource to the state and one that until now has been poorly understood and laxly managed.

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CORAL REEF RECOVERY AND REORGANISATION IN THE INDIAN OCEAN (Abstract ID: 28011)

Coral bleaching in 1998 was particularly severe in the Indian Ocean, where up to 90% coral cover was lost in some locations. I will talk about the unfolding dynamics from this disturbance event on Seychelles reefs, from both an ecological and geological perspective, and the changing structure of these reefs. Around half of the reefs in the inner Seychelles recovered towards pre-disturbance live coral states by 2014, while the other half underwent regime shifts to fleshy macroalgae. Functional diversity of associated reef fish communities shifted substantially following bleaching, returning towards pre-disturbance structure on recovering reefs, while becoming progressively altered on regime shifting reefs. These changes are also reflected in food chain lengths of reef meso-predators,

feeding on shorter, simplified chains on degraded reefs. Recovery was favoured when reefs were structurally complex and in deeper water, when density of juvenile corals and herbivorous fishes was relatively high and when nutrient loads were low. From a geological perspective, fewer reefs regained a positive carbonate budget following the bleaching event, with presence of macroalgae, massive corals, wave exposure and parrotfish biomass influencing carbonate budget outcomes. Worryingly, by 2014, few reefs had regained the attributes that promoted recovery from the 1998 event, rendering them vulnerable to future disturbance. Marine reserves had little bearing on reef trajectory, and the influence of this management system on the fish community appears to be changing.

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BETTER LIVING THROUGH PHYSICS: MAPPING REEF RESILIENCE WITH SITE-SPECIFIC ECOLOGICAL FORECASTS FOR CORAL THERMAL STRESS (Abstract ID: 29628)

Ocean physics can be used to improve the understanding of environmental impacts on coral reefs, informing decisions to conserve reefs and to sustain coastal economies by preserving reef ecosystem services. Thermal stress is an ongoing physical threat to reefs, as witnessed by widespread bleaching-related mortality in 2014 and 2015. Reefs are also under pressure from other physical and biogeochemical stressors such as land-based pollution, ocean acidification, reduced circulation, and storm damage. Attempts to moderate the combined effects of these stressors presents a challenging management scenario. Spatially explicit science - accounting for key local features - can help to focus monitoring, management, and research for informed decision making. The authors use expert systems to alert managers to ecological impacts on reefs and fisheries. "Ecoforecasts" rely on a simple ocean physics model at <100 m resolution, integrating seafloor maps with coarser-resolution data for weather, oceanography, and turbidity. Climate, weather, and human activity drive many stressors; but at the scale of reefs, oceanography dominates variability in sea temperature, water mixing and circulation. Seafloor depth and slope prove key in predicting both sea temperature extremes and cross-reef water exchange, and remotely sensed turbidity can improve temperature and benthic light predictions. Results show how data integration, artificial intelligence, and a simple model can improve assessment and prediction of relative resilience between reef sites within a jurisdiction.
http://www.coral.noaa.gov/research/physical-oceanography.html

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CHALLENGES AND OPPORTUNITIES OF CORAL REEF MANAGEMENT IN WEST AND CENTRAL AFRICA (Abstract ID: 28152 | Poster ID: 609)

The Abidjan Convention which is one of UNEP's regional seas flagship programme forming cooperative mechanism to promotes cooperation in the protection and development of the marine and coastal environment in the West, Central and Southern African Region. Pursuant its CoP decision CP 11/6 on Coral Reef Partnership: 1. To urge the Contracting Parties to consider the importance of preserving coral reefs and the services they render to ecosystems; 2. To request the Secretariat to develop collaboration with the Global Partnership on Coral Reefs of UNEP's Regional Seas Programme and other institutions, and to set up a working group charged with developing tools and methods that will allow for better management of coral reefs; 3. To exhort the Contracting Parties to respect and promote the objectives of sustainable management of the reefs, laid down in the Implementation Plan of the World Summit on Sustainable Development, in particular by establishing partnerships with the International Coral Reef Action Network (ICRAN) ; 4. To invite the Contracting Parties to contribute to the development of a global network of protected marine areas in order to better preserve the biodiversity of the coral reefs. Subsequently, two Coral Reef Projects (Sao Tome and Principe, and Cape Verde) have been identified with national Action Plans developed to support an effective management of respective Coral Reef projects.
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RIDGE TO REEF INTEGRATED TERRESTRIAL-MARINE MONITORING TO ASSESS THE IMPACT OF WATERSHED RESTORATION ON CORAL REEF SEDIMENTATION IN ST. JOHN, US VIRGIN ISLANDS (Abstract ID: 29084)

Terrigenous sediment derived from unpaved roads is a significant stressor to coral reefs in the US Virgin Islands. The 10.7 km2 Coral Bay watershed was the focus of a NOAA-ARRA watershed restoration program completed in 2011, which included: sediment retention structures, road drainage improvements, and limited road paving. An ongoing terrestrial-marine monitoring program to assess the effectiveness of this restoration at multiple spatiotemporal scales measures: (a) terrestrial erosion and runoff-sediment yields; (b) marine terrigenous sedimentation at shoreline and coral reef sites; and (c) the sediment "residence time" using short-lived radioisotopes (SLR). Paving reduced road-segment-scale erosion rates to 4-29% of pre-paving rates, but watershed modeling showed that ~90% of the ~110 Mg yr-1 reductions were due to sediment retention ponds. The high variability of marine terrigenous sedimentation rates due to sediment resuspension limited the statistical significance of mean pre- vs. post-restoration terrigenous sedimentation rate comparisons. A more promising approach has been to select sampling periods with roughly equivalent rainfall patterns for pre- vs. post- restoration comparisons and to use SLR sediment ages and nephelometers to deduce the contributions of contemporary sediment input vs. resuspension to total sediment accumulation. The Coral Bay watershed restoration and monitoring program may serve as a case study on how to develop effective management and monitoring strategies that may be applied to other areas with similar ephemeral hydrologic behavior.
http://www.sandiego.edu/cas/envi-ocean/

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LARVAL DISPERSAL AND MOVEMENT PATTERNS OF CORAL REEF FISHES: IMPLICATIONS FOR MARINE RESERVE DESIGN (Abstract ID: 27963)

Connectivity is a key ecological factor to consider in marine reserve design to maximise benefits for fisheries management and biodiversity conservation. For reserves to protect biodiversity and enhance populations of fisheries species, they must sustain focal species within their boundaries and be spaced so they can function as mutually replenishing networks while providing recruitment subsidies to fished areas. Thus the configuration (size, spacing and location) of reserves within a network should be informed by larval dispersal and adult movement patterns. Our review of movement patterns (home ranges, ontogenetic shifts and spawning migrations) of 34 families (210 species) of coral reef fishes demonstrates that movement varies among and within species, and is influenced by many factors (e.g. habitat). Some species move <0.1–0.5 km (e.g. butterflyfishes), <0.5–3 km (e.g. most parrotfishes) or 3–10 km (e.g. large parrotfishes), while others move 10s-100s (e.g. some groupers) or 1000s of kilometres (e.g. some sharks). Larval dispersal distances tend to be <5–15 km and self-recruitment is common. Synthesising this information has allowed us to provide species, specific advice on marine reserve configuration where: reserves should be more than twice the size of home ranges of focal species; reserve spacing should be <15 km; and reserves should include critical habitats for the life history of focal species, and be spaced to accommodate movement patterns among these. This information is being used to improve marine reserve design in coral reef regions worldwide.

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MODELLING THE CIRCULATION OF A SEMI-ENCLOSED ISOLATED CORAL REEF ATOLL (Abstract ID: 28633)

The hydrodynamics of coral reefs directly influence ecosystem diversity, productivity and community structure. Predicting the processes that drive reef circulation will facilitate understanding reef resilience when challenged by future climate change. Most studies on coral atolls have focused on shallow reef tops forced by surface waves, located primarily within microtidal regions. This study focuses on Scott Reef, an isolated reef atoll system that rises steeply from depths of 2500 m, ~300 km off northwestern Australia. The dynamics of North Scott, a shallow (~20m deep), semi-enclosed lagoon (exchange only through two narrow reef channels), with a spring tidal range of > 3 m, will be presented. A multidisciplinary research cruise took place during April 2015 to Scott Reef. To quantify the hydrodynamics of North Scott Lagoon, an array of moored instruments were deployed, including wave and tide gauges, and current meters/profilers. Field measurements indicate that the shallow reef crest acts to restrict exchange between the open ocean and the lagoon, resulting in a highly asymmetric tidal flows.

A numerical model (DFLOW-FM) was developed using flexible mesh gridding to account for the complex bathymetry of the reef and lagoon, and was able to replicate the hydrodynamics. Water quality variables will be incorporated into the model, to not only provide insight into the physical forcing associated with the circulation and flushing of the lagoon, but also give an indication of the system's responses to projected future environmental disturbances.

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THE COMBINED EFFECTS OF CHANGES IN TEMPERATURE AND PCO2 ON PRODUCTION OF DIMETHYLSULPHONIOPROPIONATE IN MASSIVE PORITES CORAL SPECIES. (Abstract ID: 28783)

The biogenic sulphur compound dimethylsulphoniopropionate (DMSP) is a putative antioxidant produced by corals and their symbiotic zooxanthellae. DMSP has been shown to alleviate cellular stress such as that caused by increasing sea surface temperatures and decreasing oceanic pH (ocean acidification). In this study we acclimated small colonies of massive Porites corals to three different seawater pCO2 treatments (180ppm, 400ppm and 750ppm) and two temperature scenarios (25 and 28C) over periods of several months. We cultured 4 genotypes in each treatment including individuals of P. lutea and P. murrayensis. After acclimation we measured coral photosynthesis/respiration calcification and net seawater DMSP production in the light and dark. Our analyses to date indicate consistent patterns. The net production of DMSP is lower in corals cultured at 750 ppm seawater pCO2 compared to 400 ppm. Net seawater DMSP production is lower at 25°C than at 28°C in the light regardless of pCO2 treatment. P.lutea exhibited a net release of DMSP in both the light and dark at both temperatures. But we observed a net removal of seawater DMSP in the P. murrayensis genotype at 25°C, suggesting that bacterial catabolism in some coral colonies may act to reduce seawater DMSP.

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CORAL GARDENS BELIZE: AN *ACROPORA* SPP. REFUGIA IDENTIFIED (Abstract ID: 28393)

The declining abundance of Caribbean Acropora cervicornis has been well documented, and few A. cervicornis-dominant reefs remain. Due to limited long-term monitoring of extant A. cervicornis it is difficult to assess whether existing populations are new, in recovery, or true refugia. Here we document the extent and persistence of one of the largest known extant Caribbean A. cervicornis populations. We used GIS data, survey data, and radiometric ages to show that A. cervicornis persisted and is thriving today at Coral Gardens, Belize despite a decline in abundance elsewhere. Over 7 ha of Acropora spp.-dominant reefs were mapped at Coral Gardens. Live coral was quantified from photographic data of over 130 $m^2$ quadrats each year from 2011-2014 at fixed locations. Mean live coral ranged from 33%-30% with 18% of individual quadrats having greater than 50% live coral in 2014. Live coral cover may be decreasing, but only comparatively slowly against a backdrop of rapid regional decline. To document a longer history of A. cervicornis at Coral Gardens, corals were collected at 5 cm stratigraphic intervals from a 2 m pit excavated beneath non-living reef framework. Dead corals were also carefully extracted from within living canopy using 1.5 m extendable tools. The age of 43 corals was determined using conventional radiocarbon methods and 8 (24 pending) using high-precision U-Th dating techniques. Data show corals persisting through the well documented 1980's-1990's regional die-off. We suggest that this location is a modern refugia for Acropora corals.

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MARINE CONSERVATION THROUGH ART (Abstract ID: 28071)

The Marine Foundation, founded in 2009 by artist Celia Gregory,pioneered the Living Sculptures in the Sea Eco art program. As a dive master her creative eye provided a unique perspective into the underwater world. She travelled to reefs around the world and it was clear the environmental story was depressing. Eager to help find a solution, she worked with marine scientists,ideas of artificial reef and coral gardening and realised humans do not have to have a bad effect on the sea but can effect positive change. The living sculptures merges art and science, help damaged habitats regenerate as well as creating innovative works of art. Many thought her idea was mad but now the scientists she works with agree art is powerful and emotive. Our program is fun and could be seen as fluffy but there is a serious environmental agenda e.g.our sculptures are placed in agreed No Take Zones. Working closely with the community is a vital ingredient for success. We always partner with local NGO's and help them generate ecotourism attractions and alternative sources of income. We have inspiring imagery of how life has grown on the artworks. It is this ever changing, symbiotic relationship with nature that is so special. In the cyber world the inspiring visuals spread a positive Eco story, one that is a creative, action-based solution. Over the last 8 years, we have learnt from our success and failures, creating art in the sea presents its challenges! Some people say we should just leave the sea alone ' let it go back to nature' but is that realistic with billions on the planet? http://www.themarinefoundation.org

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USING TIME LAPSE PHOTOMOSAICS TO MONITOR GROWTH AND EXPANSION OF ACROPORA CERVICORNIS THICKETS CREATED BY OUTPLANTING NURSERY GROWN CORALS (Abstract ID: 29006)

In the last decade, coral nursery operations in the Caribbean have expanded from just a few locations to over 50 programs around the Caribbean in over 20 different countries. These programs have proven to be effective at increasing the local populations of Acropora cervicornis where outplanting is conducted. Typical monitoring normally focus on individual colonies. Frequently, monitoring at the level of an individual colony becomes more complicated after 1-2 years as corals grow and intertwine, new colonies are created through fragmentation, tags can be hard to relocate as they are overgrown, etc. Longer term monitoring goals (3-5 years+) should look at a broader scale considering the whole community, the overall health of thickets, their size (expansion or reduction), asexual recruitment and changes in reef community. Photomosaics are a useful tool for this type of monitoring. The research presented here used photomosaics analyzed with Coral Point Count with Excel Extensions (CPCE) to monitor the growth and expansion of thickets that were outplanted at 2 grounding sites. Photomosaics were collected every 6-12 months. Changes in the benthic community were monitored by looking at percent cover using CPCE. Significant increases in coral cover by A. cervicornis and significant decreases in the presence of bare substrate were recorded. Several years after initial outplanting, the outplanted corals have developed into self-sustaining thickets that are expanding through assexual reproduction and have withstood impacts from multiple hurricanes and swells over 6m.

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ABUNDANCE DRIVING PHYSICAL CONTACT INTERACTIONS WITH SCLERACTINIAN CORALS IN MARGINAL REEFS (Abstract ID: 27846 | Poster ID: 310)

Understanding the mechanisms structuring ecological interactions is a main challenge in Ecology, as it can help maintain communities in different environments. Despite the worldwide distribution of marginal reefs and its clear differences to more typical reefs, few studies focus on the biology and ecology of species in these systems. Here, we quantified physical contact interactions of benthic organisms with scleractinian corals in four marginal reef areas along the Brazilian coast. We characterized these interactions using tools derived from the complex network theory. We also investigated if the interactions occurred as expected by the organisms' abundance, or if biological characteristics, such as defense tentacles of hard corals, hampered contact with other organisms. We found that abundance is a key factor structuring benthic contact interactions, regardless species identity, species richness or physical characteristics of the reef. In each area, all coral species interacted more with the most abundant benthic group, the epilithic algal matrix; and in all networks, abundant organisms interacted more among them and few interactions occurred between low abundant groups. These results suggest that, in the studied range, competitive mechanisms may not play a very significant role in shaping interactions with corals. We hypothesize that this occurred due to the unusual reef environments for corals in Brazil. Hence, species tolerance to these conditions can be more relevant than biotic characteristics in affecting ecological interactions in non-optimal environments.

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COMBINED RESPONSES OF THE CORAL MICROBIOME AND CORAL PHYSIOLOGY TO ELEVATED TEMPERATURE AND PCO2 (Abstract ID: 27996)

We experimentally investigated the links between changes in the coral microbiome and physiology in response to elevated temperature and pCO2 expected by the end of this century in two species of corals: Acropora millepora and Turbinaria reniformis. Corals were maintained under treatment (pCO2 of 750 µatm and 29.0˚C) or control (pCO2 of 364 µatm and 26.5˚C) conditions for 24 days and fed brine shrimp nauplii bi-weekly. Overall microbial communities differed between coral species, and between control and treatment fragments of A. millepora but not of T. reniformis. Under treatment conditions, A. millepora experienced a complete loss of Pseudovibrio, a 47% decline in Staphylococcus, and the appearance of Rhodococcus fascians along with a 55% decline in calcification and a 35% increase in protein content compared to controls. In comparison, control and treatment T. reniformis shared two OTU's in common (Sphingomonas and Rhodobacteraceae) and while treatment corals experienced declines in calcification and endosymbiotic algal density of 40 and 25%, respectively. Overall, protein content best described the microbial NMDS pattern of the corals with lipids being associated with the separation between treatment and controls. Thus, sensitivity of the coral microbiome to climate change is correlated with energy reserves. This is consistent with findings showing that energy reserves play a strong role in coral susceptibility and recovery to coral bleaching and suggests that energy reserves may be more crucial to coral holobiont resilience to climate change than previously appreciated.

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PHYSICAL DRIVERS OF COMMUNITY STRUCTURE AND GROWTH AMONG MESOPHOTIC CORAL ECOSYSTEMS IN ST. THOMAS, US VIRGIN ISLANDS (Abstract ID: 28834)

Mesophotic coral ecosystems (MCEs) are deep (>30m), light-dependent communities that are abundant in the northern US Virgin Islands. Compared to their shallow water counterparts, MCEs remain understudied. South of St. Thomas, mesophotic coral cover on *Orbicella*-dominated reefs can reach 50%, but observations of the northern shelf at similar depths (30-45 m) suggest limited coral cover. The cause and extent of these differences is unknown. Using spatially explicit observations of coral health, species abundances, and coral population densities, we compared northern shelf bank MCEs to previously studied MCEs south of St. Thomas. Overall coral cover is lower on northern MCEs and reefs dominated by *Orbicella* species have not been found. Factors limiting coral growth on northern MCEs may include more frequent wave disturbance as well as nutrient loading, turbidity, and thermal stress associated with upwelling. To assess if disturbance and growth are driving community structure, we collected 30 colonies each of *Orbicella franksi* and *Porites astreoides* from 27 to 47 m depths on the north and south shelves of St. Thomas. Using CT to quantify calcification, we will identify environmental factors correlated with coral growth across sites. We predict slower growth rates of mesophotic corals north of St. Thomas, corresponding to lower light conditions and more frequent disturbance. These results will identify processes that influence the structure of MCEs and, thus, help to predict their global distribution and utility as refugia.

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COMMUNITY PRODUCTION AND RESPIRATION IN AN EXTREME ENVIRONMENT: NEW INSIGHTS FROM TROPICAL TIDE-DOMINATED FRINGING REEFS (Abstract ID: 29424)

The cycling of carbon and nutrients within benthic reef communities is driven by a suite of environmental factors including water composition, hydrodynamic regime, temperature, and light. Although in the past most studies of reef biogeochemistry have focused on wave-dominated systems, tide-dominated reefs are frequently found throughout the Indo-Pacific and eastern Africa and yet the environmental forcing of these systems remains poorly understood. We conducted a study in the remote and pristine Kimberley region of Western Australia where large semidiurnal tides (12m range) drive rapid changes in light, temperature (up to 10 deg. C over 6 hours), and water chemistry. We measured community production and respiration in seagrass and algal-dominated communities present on an intertidal reef flat over a full spring-neap tidal cycle during both wet and dry seasons using a 1-D control volume approach. High rates of community respiration routinely drove reef flat oxygen levels to hypoxia at night. Gross community production was found to be free from photoinhibition in all communities, even during periods of exposure to high light. Results from this study highlight the phase difference between diurnal tide and light cycles as a key control on daily rates of community production and respiration. Overall, we find that reef communities in this shallow, tropical, and tide-dominated habitat are highly productive and display remarkable tolerance to life in a strongly variable environment.

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INDIRECT EFFECT OF LONGTERM CLEANER WRASSE PRESENCE ON THE BENTHIC COMMUNITY (Abstract ID: 28552)

An ongoing manipulation of cleaner wrasse at Lizard Island, Great Barrier Reef, showed that the abundance and species richness of grazer fishes is reduced on patch reefs maintained free of cleaners for 8.5 y compared with controls (both treatments at 2 sites). Here, we tested whether this affected the benthos, by investigating potential flow-on affects to coral, algal turf, and sediment load dynamics after 12-14 y of manipulating reefs. The % cover of natural benthos (hard coral, dead coral, soft coral, algae, other) did not differ with cleaner presence; but algal subtypes (calcareous, fleshy, and low, medium, and high turf height) differed between sites. Algal height on settlement tiles (20 x 20 cm) over 2 y did not differ with cleaner presence, but varied among times sampled - possibly due to cyclonic events. When dried, algae plus detritus weight per tile decreased with increasing sediment but did not differ with cleaner presence; sediment weight did not differ with cleaner presence. Video showed the grazer/detritivore *Ctenochaetus striatus*as the most common large-bodied fish feeding off tiles, however many other fishes interacted with tiles including farming damselfishes. *C. striatus*abundance did not differ with cleaner presence but did between sites - possibly explaining observed differences in feeding and bite rates between sites. Tile composition and organic content, fish species composition and video analysis is currently underway. The study reveals the challenges of detecting potential indirect effects of fish and benthic interactions.

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SEEDING OF EARLY-STAGE SEXUAL RECRUITS OF ACROPORA PALMATA FOR SPECIES AND HABITAT REHABILITATION (Abstract ID: 28790)

Populations of *Acropora palmata* , a keystone reef-building coral in the Caribbean, have decreased significantly since the 1970s. Although some populations still spawn, no significant recruitment of juveniles has been observed throughout the Caribbean, hence rehabilitation of denuded reefs to aid recovery is urgently needed. Here, we present the results of seeding one-polyp stage *A. palmata* sexual recruits on a degraded, former *A. palmata*reef. Two weeks after settlement, we introduced 500 SUs (=SExual COral REproduction Seeding Unit, SECORE SU) on 120 $m^2$ of degraded reef in Picudas, Puerto Morelos, Mexico. Larvae for this assay were obtained in August 2015 after collecting gametes from a spawning event in a nearby reef. The rehabilitation area was divided into 1 m width transects and SUs were wedged in natural crevices formed by the reef framework at a density of 4 SUs per $m^2$ without the use of concrete or fixative. To evaluate SU

performance as well as recruit survival and growth, 60 quadrants were chosen randomly and will be monitored for one year. Preliminary results show that two months after the seeding effort, 80% of the SUs remained in the area at a density of 3 SUs per $m^2$ with approximately 82% of the SUs having more than 10 recruits/SU. These results indicate the potential of rehabilitating *A. palmata* reefs using SUs with sexual recruits. Additionally, the reduction in pre- and post-settlement care significantly decreases costs and labor.

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A TRANSCRIPTOMIC PIPELINE TO UNDERSTAND THE SYMBIODINIUM COMMUNITY CHANGE AND FITNESS IN POCILLOPORA DAMICORNIS DURING THERMAL STRESS (Abstract ID: 29679)

Since the proposition of the Adaptative Bleaching Hypothesis, stating that bleaching might allow corals to rapidly adapt to environmental change by modifying their *Symbiodinium* community, research on the diversity and physiological properties of coral symbionts has progressed significantly. However, the *Symbiodinium* assemblage of a given coral colony has still rarely been assessed over a stress event and, when studied, the molecular approaches to identify clades and subclades used the DNA of the holobiont as a template. While such approaches yield fine-scale assessments of the clades hosted by the corals, they do not allow for testing their fitness. To fill this gap, we developed a transcriptomic analysis pipeline using the data issued from a time series performed on the coral *Pocillopora damicornis*under simulated thermal stress. Our analysis was based on one chloroplastic (23S) and three nuclear (28S, ITS2, 18S) ribosomal markers of *Symbiodinium*and *P. damicornis*. Our approach follows three main steps: (1) creation of a database issued from all available *Symbiodinium* DNA sequences, (2) selection of unique kmers representative of each clade or subclade and (3) quantification of the markers' expression levels at each point of the stress test time series, by establishing clade and/or subclade/coral host expression ratios. Our results will be discussed in terms of marker robustness and the effects of thermal stress on *Symbiodinium* community change and fitness.

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IMPROVING CAPACITY FOR CORAL REEF FISHERIES MANAGEMENT IN MICRONESIA THROUGH SOCIAL MARKETING CAMPAIGNS (Abstract ID: 30136)

Over the past four years, Rare has supported local organizations and individuals in undertaking social marketing campaigns for natural resource management through its Micronesia Program for Island Resiliency. Within the context of this program, local campaign managers were trained in behavior change and conservation strategies to enhance on-going efforts in improving coral reef fisheries and nearshore marine resource management. At seven sites across the region and with the assistance of numerous supporting partners, managers conducted basic research; developed conservation strategies; designed stakeholder and community engagement plans; and executed social marketing campaigns to improve awareness, compliance, and behaviors that support effective coral reef management. In many cases, managers equipped with new skills and tools were able to organize communities, assimilate information from a variety of sources, build and strengthen alliances of stakeholders and agencies, and improve compliance and management efforts. Examples will be presented of how campaigns increased interaction, communication, and collaboration among scientists, fishers, managers, traditional leaders, and politicians to undertake new initiatives that lead to improved management. Details will be provided on how these efforts supported community-based MPA improvements, rights-based fishery management development, new policy and regulations, increased compliance, and fish marketing enhancements that are intended to provide benefits to fishers and contribute to overall fisheries sustainability.
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COASTAL HIGH-RESOLUTION OBSERVATIONS AND REMOTE SENSING OF ECOSYSTEMS (C-HORSE) (Abstract ID: 29966 | Poster ID: 539)

Coastal benthic marine ecosystems, such as coral reefs, seagrass beds, and kelp forests are highly productive as well as ecologically and commercially important resources. These systems are vulnerable to degraded water quality due to coastal development, terrestrial run-off, and harmful algal blooms. Measurements of these features are important for understanding linkages with land-based sources of pollution and impacts to coastal ecosystems. Challenges for accurate remote sensing of coastal benthic (shallow water) ecosystems and water quality are complicated by atmospheric scattering/absorption (~80+% of the signal), sun glint from the sea surface, and water column scattering (e.g., turbidity). Further, sensor challenges related to signal to noise (SNR) over optically dark targets as well as insufficient radiometric calibration thwart the value of coastal remotely-sensed data. Atmospheric correction of satellite and airborne remotely-sensed radiance data is crucial for deriving accurate water-leaving radiance in coastal waters. C-HORSE seeks to optimize coastal remote sensing measurements by using a novel airborne instrument suite that will bridge calibration, validation, and research capabilities of bio-optical measurements from the sea to the high altitude remote sensing platform. The primary goal of C-HORSE is to facilitate enhanced optical observations of coastal ecosystems using state of the art portable microradiometers with 19 targeted spectral channels and flight planning to optimize measurements further supporting current and future remote sensing missions.

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LONG-TERM MONITORING OF AN ASSEMBLAGE OF THE HOST ACTINIAN, HETERACTIS MAGNIFICA, IN RAS MOHAMMAD NATIONAL PARK, SOUTH SINAI, EGYPT (Abstract ID: 28680)

The coral reefs around Sharm el-Sheikh, Egypt, are under heavy pressure from tourists and the dive sites are experiencing reduced growth and regeneration. An impressive assemblage of the host actinian, Heteractis magnifica, commonly known as "Anemone City", is located in the Ras Mohammad National Park at the tip of the Sinai Peninsula. The actinians are often located in clusters, which make Anemone City a special habitat for the inherent Red Sea Anemone fish, Amphiprion bicinctus. The actinian assemblage was monitored in 2002 and divided into 9 subpopulations on the reef. This study was a re-monitoring and assessment of the development from 2002 to 2015. The actinians were counted, mapped, classified as solitary or clustering and the area of oral disc was measured. The number of adult and subadult anemone fish was counted in each subpopulation of actinians. The study reveals that the assemblage has not changed much since 2002 in terms of total number of actinians, total actinian cover and number of clusters. However the actinians in the subpopulations in the periphery areas of the reef have in general increased their numbers, while they have decreased in the subpopulations at the central plateau. The amount of anemone fish has declined by 14 % for adults and 29 % for subadults. The decline in anemone fish abundance has resulted in an average of 1 anemone fish per actinian and only 0,42 adult anemone fish per actinian, which is highly unusual for an assemblage of host actinians. The findings are being discussed in relation to the diving practices in the Sharm el-Sheikh area.

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THE ICRI GLOBAL CORAL ECOLOGICAL SERVICES AND FUNCTIONS VALUATION TOOL (Abstract ID: 28144 | Poster ID: 618)

The new International Coral Reef Initiative (ICRI) Coral Ecological Services and Functions tool was developed to account for the values inherent in different coral species of different size classes that grow in different habitats and sub-habitats. The tool can be used with any stony coral species worldwide and is easily adapted for any jurisdiction. The coral ecological value (CEV) of corals found in nature is defined as the product of individual values given to their morphology, rarity, endemism and size class with the CEV-metric acting as a unit-less metric. The valuation tool itself is very simple and does not require extensive knowledge beyond inputting a few variables: the species of coral for each colony impacted along with its dominant growth form and rarity in your area; the size of each colony impacted; and the type of sub-habitat (substrate) each colony occurs on. Each of these is selected from pre-provided lists. The tool itself is very transparent and provides guidance along each step as to what it is doing. The total coral ecological value (CEV) is then simply tabulated as the product of each of the individual metrics: The tool can be incorporated into any country's natural resource trustee activities for evaluating impacts from human activities, and for establishing both restoration and compensatory mitigation targets.

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INTEGRATED CONSERVATION AND DEVELOPMENT: EVALUATING A COMMUNITY-BASED MARINE PROTECTED AREA PROJECT FOR EQUALITY OF SOCIOECONOMIC IMPACTS (Abstract ID: 29227)

Despite the prevalence of protected areas, evidence of their impacts on people is weak and remains hotly contested in conservation policy. A key question in this debate is whether socioeconomic impacts vary according to social subgroup. Given that social inequity can create conflict and impede poverty reduction, understanding how protected areas can differently affect people is critical to designing them to achieve social and biological goals. Here, we assessed whether the socioeconomic impacts of marine protected areas – designed to achieve the dual goals of conservation and poverty alleviation – differed according to age, gender or religion in associated villages in North Sulawesi, Indonesia. Using data from pre-, mid- and post-implementation of the MPAs for control and project villages, we found some empirical evidence that impacts on five key socioeconomic indicators differed according to social subgroup. We found significant inequality of impacts to environmental knowledge in relation to age and religion over the medium and long term. These findings help elucidate the pathways through which the impacts of the MPAs occurred, and may be used to improve targeting of management activities. Further, our evaluation identified some key limitations of current approaches to impact evaluation in relation to social equity, and thus provides guidance for future research in understanding how protected areas affect people.

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DIVERGENCE THROUGH SPECIES INTERACTIONS: THE ROLE OF THE SPONGE CLATHRIA OXEOTA IN ECOLOGICAL SPECIATION OF THE OCTOCORAL BRIAREUM ASBESTINUM (Abstract ID: 29445)

Environmental variation and competition for resources can trigger phenotypic change in marine organisms. Thus life history traits such as growth rate, morphology, reproduction and ecological interactions may be modified increasing fitness. Morphological variation, if reinforced by divergent selection, may reduce gene flow and eventually lead to fixed differences in ecologically segregated populations. Ecological, morphological and genetic divergence between encrusting and erect morphotypes of the Caribbean octocoral Briareum asbestinum was studied in populations of Curaçao, Puerto Rico and Colombia. An interspecific association was found between the encrusting morphotype -also known as B. polyanthes- and the encrusting sponge Clathria oxeota identified through Cytochrome Oxidase I barcode. Furthermore, an overgrowing pattern affecting various species of octocorals was consistently reported when such association was present, suggesting a possible advantage for space competition. Genetic divergence was studied using the method 'fields for recombination', which is useful in delimiting species boundaries based on allelic exclusivity. Using the nuclear marker ITS2, an intermediate level of divergence, and a higher degree of allelic exclusivity was found in B. polyanthes than the erect morphotype B. asbestinum. By integrating eco-morphological and genetic information, we suggest that the interaction of B. polyanthes and C. oxeota, drives the ecological and morphological divergence and promotes genetic differences that potentially could be fixed between the two morphotypes of B. asbestinum.

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USING *PTEROIS VOLITANS* INVASION TO DESCRIVE CONNECTIVITY IN MARINE PROTECTED AREAS IN THE GULF OF MEXICO AND CARIBBEAN. (Abstract ID: 28883)

The lion fish ( *Pterois volitans* ) has been responsible for one of the most successful and fast invasions of the Atlantic. Since its first apparition in the 90's in Florida, the scientists predicted that its dispersion would spread all over the east coast of the American continent. And in fact, this lionfish has invaded coastal seascapes from New York to Brazil. Due to its rapid dispersion, this lionfish could be an extraordinary tracker of connectivity in general and more specifically among marine protected areas in the Gulf of Mexico (GM) and the Grand Caribbean (GC). To further explore this relationship, a total of 475 samples were collected and identified by mtDNA as *Pterois volitans* . They were subsequently characterized with 12 microsatellite markers. Genetic analyses reflect a structured distribution suggesting restricted connectivity among marine protected areas with the GC appearing more isolated and differentiated. The Bayesian clustering analysis showed that individuals pertain to four genetic groups, suggesting that currents and topography patterns play an important role in the distribution of the allelic frequency of this specie. These results also indicate that the GC and GM groups might issued from two different roads of invasion. This results are important for management populations of coral reef fish, because even though this species is invasive with a successful breeding and high rate of survival in extreme conditions, it shows some limited trend of connectivity in GC and GM.

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GLOBAL MICROBIALIZATION OF CORAL REEFS (Abstract ID: 28248)

Microbialization refers to the observed shift in the trophic structure of ecosystems from macrobes to microbes. The increased but less efficient microbial activity drives down dissolved organic carbon (DOC) concentrations depleting availability of these resources to higher trophic levels. The posited mechanism for the observed microbialization is a positive feedback loop, where DOC released by ungrazed fleshy algae fosters copiotrophic, potentially pathogenic bacteria, ultimately leading to coral disease and increased algal competitive dominance (DDAM: DOC, Disease, Algae, Microbes). Here we provide geochemical and microbiological evidence that microbialization is tightly coupled to phase shifts in benthic reef communities on a global scale. Using an unprecedented dataset of >400 samples on 60 coral reef sites in the Atlantic, Pacific, and the Indian Ocean we show that increased algal cover correlates with lower concentrations of DOC and higher microbial abundances. Metagenomes constructed from a subset of reefs demonstrated a shift in microbial community metabolism away from efficient glycolysis towards faster, but less efficient alternative catabolic pathways. Sacrificing energetic efficiency to outgrow and deprive competitors of food is a common ecological strategy referred to as the yield to power switch. This global dataset provides evidence that fleshy algae foster, genomically adapted microbial communities that threaten reefs directly through higher disease prevalence and by depleting oxygen and organic nutrients at the expense of higher trophic levels.

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STABLE MUCUS-ASSOCIATED MICROBIAL COMMUNITIES IN BLEACHED AND NON-BLEACHED PORITES FROM THE ARABIAN SEAS (Abstract ID: 27888)

Coral reefs are subjected to a serious threat due to a phenomenon called coral bleaching, which is described by the physical whitening of the coral colony due to loss of its endophotosymbiotic algae. While the importance of bacteria to coral holobiont functioning is well established, there are comparatively few studies that studied bacterial communities associated with coral mucus. A substantial number of the coral microbial community resides within the mucus layer, however the effect of bleaching on the mucus-associated microbial community is poorly understood. In this study, mucus from bleached and healthy Porites colonies were collected from multiple reefs in the Red Sea and the Arabian Gulf in order to investigate microbial changes associated with health condition and site. Using 16S rRNA gene amplicon sequencing, we found that microbial richness and composition was similar in bleached and healthy colonies, but differed by site. Our data show that bacterial taxa composition of coral mucus seems to be stable and almost unaffected by bleaching emphasizing the ephemeral nature of coral mucus. The notion that distinct bacterial taxa structure the microbiomes of Porites in the Red Sea and the Arabian Gulf indicate that prevailing environmental conditions might be a strong driver of coral mucus microbiome structure. At the same time, specific bacterial groups, e.g. nitrogen-fixing bacteria seem to be site-specifically affected. Further research is needed to unequivocally resolve the distinct contribution of this group of bacterial to coral bleaching.

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WHO MAKES THE SETTLEMENT CUE FOR LARVAE OF THE CORALIVOROUS NUDIBRANCH *PHESTILLA SIBOGAE*? (Abstract ID: 28981)

When larvae of the nudibranch *Phestilla sibogae* are exposed to seawater (SW) in which pieces of the nudibranch's prey coral, *Porites compressa*, have been soaked, they settle and metamorphose. The inducer is a small (<500 DA) polar molecule. Knowing that any hermatypic coral is a community of coral, symbiotic dinoflagellates, bacteria, and probably fungi, we here ask, which partner makes the settlement inducer? This study attempts to eliminate all but one of the possible sources. To eliminate the dinoflagellate as a source, live coral pieces were maintained in full darkness for 5 dy, with daily transfers to fresh SW. The last batch of SW was filtered and subjected to a larval assay. Despite a shutdown in photosynthesis, the inducer was still present. Maintaining coral in the dark in the presence of the photosynthesis inhibitor DCMU also failed to reduce induction,

further reducing the likelihood that dinoflagellates make the inducer. To examine a role for bacteria in production of the inducer, corals were steeped in SW containing one of seven different antibiotics, representing five different modes of action, and the resulting SW tested for induction. All preparations remained strongly inductive. Although SW containing fungicides to which corals had been exposed killed the larvae, fungi isolated and cultured from the coral produced no soluble settlement inducer. Thus, results to date support the hypothesis that it is the coral itself whose metabolite is the inducer of recruitment of its nudibranch predator.
http://www.kewalo.hawaii.edu/index.php/2013-08-02-03-42-22/faculty/michael-g-hadfield

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REFLECTIONS ON MODERN AND HISTORIC APPROACHES TO MAPPING CORAL REEF ENVIRONMENTS AT ALDABRA ATOLL (Abstract ID: 29025)

In February 2009, a team from Cambridge Coastal Research Unit embarked on an expedition to map the lagoon of Aldabra Atoll, western Indian Ocean. Here, we reflect on the modern and historical mapping techniques applied across the lagoon and atoll rim. Ground referencing was conducted from a boat to support the production of a lagoon map from three high resolution satellite remote sensing images. Topographic surveys were undertaken with a level and staff to accurately determine the height of a tide gauge deployed in a lagoon channel in relation to a control point some 1.5 km away. Our experiences highlight the changing nature of field survey techniques, in particular the amount of effort required to record observations for the purpose of mapping. The broader value of maps as important sources of time-specific information on the configuration of landforms such as coral reef platforms and islands is considered using a range of case studies from the Atlantic, Indian and Pacific Oceans. These explore the ways in which David Stoddart's maps have been used to assess shoreline movements at Diego Garcia, to validate models of island response to environmental change on the Great Barrier Reef and to assess changes to mangrove environments on the Belize cays. These examples illustrate the importance of the many reef platform and cay maps that are part of the legacy of David Stoddart's reef geographical expeditions.

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PHYSIOLOGICAL RESPONSES AND DIFFERENTIAL MORTALITY OF THE SEA ANEMONE EXAIPTASIA PALLIDA TO LONG TERM OCEAN ACIDIFICATION AND A SIMULATED TEMPERATURE ANOMOLY (Abstract ID: 29659 | Poster ID: 416)

Recent experimental and natural studies note positive outcomes of high CO2 exposure for symbiotic sea anemones. Yet, as with scleractinian corals, the majority of data comes from short-term, single parameter studies. We quantified physiological responses of Floridian E. pallida, separately hosting three Symbiodinium strains, to long term, diel cycling, high CO2 (1010-733 ppm, 111 days), combined with a simultaneous thermal increase to 32 C (5 days). Photosynthesis to respiration (P:R) ratios increased under high CO2 in animals hosting two different strains of Symbiodinium type A4, but declined under combined heat and high CO2. P:R in animals with Symbiodinium minutum (B1) showed minimal change to CO2 and an earlier decline with combined heating. Levels of photodamage, bleaching and mortality under the combined heating/CO2 treatment were significantly higher in anemones hosting B1 than A4. Similar to previous results with a clonal host line, asexual reproduction under high CO2 increased markedly in animals hosting B1, but only within the first month of exposure, while those hosting the A4 symbionts displayed minimal change in reproduction due to CO2 exposure. Among juvenile anemones, those hosting B1 displayed the greatest mortality with heating, while less, yet differential, mortality was noted between anemones hosting the A4 symbionts. While clonal animals reveal some effects of high CO2, our data provide evidence that the positive effects of increased CO2 on symbiotic sea anemones might not persist in an environment characterized by stochastic high-temperature anomalies.

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PUBLIC INVOLVEMENT IN CORAL REEF MANAGEMENT, THE RESULT OF THREE CITIZEN PARTICIPATORY APPROACHES CONDUCTED IN SULAWESI, INDONESIA (Abstract ID: 27964)

Environmental problems are highly dynamic and complex, i.e. 'wicked'. They, therefore, require a creative and transparent decision-making process that accommodates a diversity of needs, forms of knowledge and human values. A growing body of research has shown the need for public involvement in any environmental management effort, including the management of coral reefs. This paper reports the results of three different public deliberation exercises centering on coral reef management in Sulawesi, Indonesia. Three deliberative group discussion methods, namely Planning Cells, Focus Group Discussions and Musyawarah, were employed in three different locations on Sulawesi. The outcomes of these exercises revealed that the majority of the threats in these areas are anthropogenic. Destructive and illegal fishing activities are still occurring as the result of limited monitoring and low level of law enforcement. To improve coral reef ecosystem and its management, the participants proposed to improve community awareness and participation, to increase the effectiveness of monitoring and law enforcement, and to implement an accepted fisheries management regulation.

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PLASTICITY OF SEA ANEMONES ALONG VOLCANIC PH GRADIENTS (Abstract ID: 29497)

Natural CO2 vents are recognized as in situ study sites to understand effects of ocean acidification on marine organisms and there is evidence that non-calcifying Cnidarians proliferate in these environments. The symbiotic anemone *Anemonia viridis* and the non-symbiotic anemone *Actinia equina*are prevalent at all pH sites around the CO2 vent found at Levante Bay (Vulcano, NE Sicily, Italy). The aim of our study was to determine if these species are highly plastic or if they are acclimated to each pH site, as well as to determine if an intertidal species (*A. equina*) response differs from a subtidal species (*A. viridis*). To answer this, short term translocation experiments were performed, examining physiological response when organisms from one pH environment were exposed to other pH environments. Anemones were translocated from low (7.4), mid (7.6), high (8.1), and reference (8.1 – outside of volcanic area) to each pH environment and exposed for 30 minutes to evaluate respiration rate for *A. viridis* and *A. equina*, and photosynthetic rate, symbiont density, protein and chlorophyll for *A. viridis*. We observed significant decreases in photosynthesis only when*A. viridis* from mid sites were translocated to high sites. We also observed that respiration rates of *A. equina* were highest at reference sites and did not change when exposed to other pH environments. Low variability in translocation response indicates plasticity in both of these organisms along pH gradients.

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WHY DO CORAL REEFS THRIVE IN ICEHOUSE WORLD CLIMATES? CLUES FROM LARGER BENTHIC FORAMINIFERS (Abstract ID: 28698 | Poster ID: 292)

In the past 25 years, foraminifers that host algal endosymbionts (aka large benthic forams or LBF) have become widely used as bioindicators for carbonate-depositional environments, both fossil and modern. This is particularly true for *Amphistegina*, which is nearly circumtropical in modern oceans and has a long fossil record. They exhibit bleaching, induced by photo-oxidative stress similar to bleaching in zooxanthellate (Z-) corals, though responding more directly to photic stress. Yet though Z-corals have declined dramatically on the offshore reefs of Florida, LBF have continued to thrive in the clearest offshore habitats. The highest coral cover is now on patch reefs, where LBF populations tend to be low or highly variable. The Cenozoic fossil record provides clues to this divergence. During the Eocene, when global temperatures and atmospheric $CO_2$ were higher than pre-Industrial modern levels, LBF were important producers of carbonate buildups; Z-corals typically occupied mesophotic conditions, either deeper or at reduced water transparency. A long-recognized paradox of Z-corals is that, despite requiring warm-water to thrive and build substantial reefs, coral reefs became prominent with the onset of Icehouse World climates. By their production of calcite rather than aragonite, and by hosting a diversity of symbiont taxa, the LBF provide additional models of how organisms with potential to hypercalcify respond to environmental conditions and especially to changes in the suites of conditions, useful to the study of reefs in the past, present and future.

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RESHUFFLING OF GLOBAL MARINE BIODIVERSITY UNDER CLIMATE CHANGE (Abstract ID: 27993)

Anticipating the effect of climate change on biodiversity, in particular on changes in community composition, is crucial for adaptive ecosystem management but remains a critical knowledge gap. We use climate velocity trajectories, together with information on thermal tolerances and habitat preferences, to project changes in global patterns of marine species richness and community composition under IPCC Representative Concentration Pathways (RCPs) 4.5 and 8.5. Our simple, intuitive approach emphasizes climate connectivity, and enables us to model over 12 times as many species as previous studies. We find that range expansions prevail over contractions for both RCPs through the year 2100, producing a net local increase in richness globally, and changes in composition driven by the redistribution rather than loss of diversity. These invasions homogenize present-day communities across multiple regions. High extirpation rates are expected regionally, particularly in the tropics (for example, Indo-Pacific) and under RCP8.5, leading to strong decreases in richness and likely creation of novel communities where invasions are common. The overlap of these patterns with contemporary human impacts highlights where current action can help promote resilience to climate change. These results strongly suggest that conservation plans based on current global marine diversity patterns will likely fail in the long run.

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REPRODUCTIVE PERIODICITY OF BROODING CORAL SPECIES IN SOUTHWESTERN PHILIPPINES (Abstract ID: 29186)

Understanding the reproductive biology of corals is critical to the management and conservation of coral reefs. Sexual reproduction is important to the recovery and persistence of corals. Data on the sexual reproduction of corals in Southwestern Philippines are lacking. Here, we report the first documentation of the lunar and diel timing of planulation of three brooding coral species: Pocillopora damicornis, Seriatopora caliendrum and Porites cylindrica in Bongao, Tawi-Tawi. We monitored the planulation of these corals from August 2014 to September 2015. All three species released larvae all year round. Planulae of P. damicornis and S. caliendrum were released around the last quarter moon and new moon. Planulae of P. cylindrica were released throughout the lunar phase but more planulae were released around the last quarter moon and new moon. All three species released planulae all day. The peak release of larvae for P. damicornis, S. caliendrum and P. cylindrica on a diel cycle occurred at 2000 to 0800 h, 0300 to 0700 h, and 2000 to 0200 h respectively. Our findings on timing of planulation will facilitate expanded research on these species.

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HYPERSTABILITY MASKS DECLINES IN BUMPHEAD PARROTFISH (BOLBOMETOPON MURICATUM) POPULATIONS (Abstract ID: 28455)

Bolbometopon muricatum, the largest species of parrotfish, is a functionally important species that is characterised by the formation of aggregations for foraging, reproductive and sleeping behaviours. The locations of aggregations are often known to local fishers and therefore vulnerable to overfishing, and are likely to exhibit hyperstability, the maintenance of high catch per unit effort (CPUE) while population abundance declines. In this study we provide a clear demonstration of hyperstable dynamics in a commercial B. muricatum fishery in Isabel Province, Solomon Islands. Initially we used participatory mapping to demarcate the Kia fishing grounds into nine zones that had experienced different levels of historical fishing pressure. We then conducted comprehensive underwater visual census (UVC) and CPUE surveys across these zones over a 21 month period in 2012-2013. The individual sites for replicate UVC surveys were selected using a generalized random tessellation stratified variable probability design, while CPUE surveys involved trained provincial fisheries officers and local spearfishermen. A comparison of fishery independent abundance data and fisheries dependent CPUE data indicate extreme hyperstability, with CPUE maintained as B. muricatum abundance declines towards zero. Our finding of hyperstability may explain the sudden collapses of many B. muricatum spear fisheries across the pacific, and highlight the limitations of data-poor fisheries assessment methods for evaluating the status of commercially valuable coral reef fishes that form predicable aggregations.

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SPATIAL DISTRIBUTION OF DAMAGE AFFECTS CORAL TISSUE REGENERATION, SKELETAL GROWTH, AND MORPHOLOGY (Abstract ID: 28732)

Many coral predators remove coral tissue, leaving small areas of exposed coral skeleton. While the effects of scar shape and size on tissue regeneration are known, the effect of spatial distribution of scars on healing, growth and morphology is still unknown. Polyps share nutrients with their neighbors, and thus, scar distribution likely affects recovery from damage, as well as contributes to variation in morphology due to differing calcification rates during recovery. To determine the effects of damage patterns on coral response, we conducted several studies in Moorea, French Polynesia: 1) field surveys documenting the spatial distribution of scars on corals, 2) field experiments testing the effect of the distance between scars on coral tissue healing, skeletal growth, and morphology, and 3) field surveys relating predator (corallivorous snail) presence to coral morphology and linear extension. These studies show scars were located close to one another and coral tissue regeneration was highest in scars >25 mm from each other, although skeletal growth is lowest. Additionally, scars near one another reduced linear extension a year later, while corals with scars far apart showed no difference in growth from control corals. Finally, corallivorous snails were associated with lower rates of skeletal growth and bumpier areas of the colony. These results suggest clustered coral damage has a greater effect on coral growth and recovery from damage than damage spread throughout the colony and could contribute to topographically diverse reefs.

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POPULATION STRUCTURE OF THE CORAL, AGARICIA LAMARCKI FROM SW PUERTO RICO AND U.S. VIRGIN ISLANDS (Abstract ID: 27774 | Poster ID: 336)

Drastic declines in coral abundance and health have been documented worldwide within the past few decades, threats to these ecosystems range from both local and global inputs. Shallow coral reefs are highly affected, conversely, deeper reefs below ~30 meters, otherwise known as mesophotic coral ecosystems (MCEs) remain relatively healthy. The Deep Reef Refugia Hypothesis (DRRH) has been proposed to test if MCEs might be acting as larval resources for the highly impacted shallow reefs, although a bulk of contemporary studies suggests a lack of gene flow between shallow and deep reefs across many coral taxa. However, within southwestern Puerto Rico plating corals, Agaricia spp., displays both a wide depth distribution, aids significantly in reef growth and habitat formation and encompasses several species and related taxa, yet no specific population information is available in this genus. This study aims to estimate structure and/or connectivity of a particularly conspicuous member of the genus, A. lamarcki from horizontally and vertically segregated populations across southwestern Puerto Rico (PR) and the U.S. Virgin Islands (USVI). By using single nucleotide polymorphisms (SNPs) generated by double digestion restriction site associated DNA sequencing (ddRAD), we will be testing the DRRH, as well as infer levels of gene flow from both local and distant populations across the PR and USVI platform. Information from this investigation will be used to aid managers in establishing effective Marine Protected Areas and highlighting reefs with high genetic diversity.

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DO SMALL SCALES MAKE A BIG DIFFERENCE? UNRAVELING THE INFLUENCE OF RECENT THERMAL HISTORY ON CORAL BLEACHING SUSCEPTIBILITY AT DAILY AND WEEKLY TIME-SCALES (Abstract ID: 29582)

Recent thermal history plays a critical role in coral susceptibility to bleaching. Degree Heating Weeks and large-scale remote sensing products can accurately predict bleaching episodes across oceanic-scales. However, there is often a mismatch between these metrics and small-scale geographic and temporal variability during local bleaching events. In an effort to reconcile regional predictions with local patterns of variability, we performed a high-resolution examination of the influence of recent thermal history on coral bleaching susceptibility of *Porites lobata* and *Goniastrea retiformis* on Ofu Island, American Samoa. Clonal replicate nubbins from multiple colonies of each species were transplanted from a source site with moderate temperature variability to 3 sites representing low, moderate, and high temperature variability. After acclimation to contrasting conditions, individuals from each site were assayed for thermal tolerance five times (after six months and six months plus 2, 7, 14 and 18 days). Multivariate analyses will be used to explore the influence of fine-scale thermal history on the bleaching susceptibility of these species. We aim to reveal temporal differences in coral thermal tolerance by exploiting the natural variability of Ofu Island's nearshore environments.

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SLIM, A HIGH-RESOLUTION MULTI-PURPOSE DISPERSAL MODELING TOOL FOR THE GREAT BARRIER REEF (Abstract ID: 28320)

High-resolution ocean circulation models are required to simulate the complex and multi-scale currents that drive physical connectivity between marine ecosystems. However, standard coastal ocean models rarely achieve a spatial resolution of less than 1km over the >100km spatial scale of dispersion processes. Here we use the high-resolution unstructured-mesh coastal ocean model SLIM that locally achieves a spatial resolution of ~100m over the scale of the entire Great Barrier Reef (GBR). Using such a high-resolution model allows us to simulate the classical cascade from large-scale to small-scales, but also a feedback from the small-scale to the large-scale. By coupling SLIM with a biophysical model of larval dispersal we can track the position of virtual larvae or propagules released into the simulated domain. Connectivity matrices are then generated from the positions of the particles at the start and at the end of the simulations. Useful information can be extracted from these large matrices by using graph theory tools such as community detection, page rank, influence rank and HITS algorithms. These methods are illustrated for different applications including connectivity between submerged and near-sea-surface coral reefs, dispersion of seagrass propagules and crown-of-thorns starfish outbreaks. Our study suggests that combining a high-resolution ocean model with novel graph theory algorithms is a powerful tool for studying physical connectivity between marine ecosystems and informing management decisions.

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DECOUPLING OF PHOTOSYNTHESIS AND EXTRACELLULAR SUPEROXIDE PRODUCTION BY CORALS AND THEIR SYMBIONTS (Abstract ID: 29633 | Poster ID: 86)

The reactive oxygen species (ROS) superoxide has been implicated in both beneficial and detrimental effects in cnidarian corals, ranging from pathogenic disease resistance to coral bleaching. At present, heat-induced impairment of photosynthetic electron transport in *Symbiodinium* is considered the primary process responsible for ROS production in symbiotic corals. Nevertheless, there exists a paucity of studies directly measuring ROS, including superoxide, in corals and their symbionts. Here, we quantified in situ extracellular superoxide levels at the surfaces of *Porites astreoides* in aquaria and both pigmented and bleached *P. compressa*colonies over a diel cycle within reefs during a natural bleaching event in Hawaii. Our results demonstrate high in situ concentrations of superoxide at the surface of pigmented and bleached corals that were not correlated with*Symbiodinium* abundance or significantly different over a diel cycle. Given the inability for superoxide to cross biological membranes, this superoxide is attributed to the activity of external bacterial symbionts or coral animal itself. Further, diel extracellular superoxide production by *Porites*-derived symbionts, including *Symbiodinium* and *Endozoicomonas*, were found to be light-independent, indicating that this production was decoupled from photosynthetic activity. These findings highlight the need to obtain discrete measurements of ROS in the coral holobiont to define the sources, regulation, and consequences of these species to coral health.

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UNDERWATER HYPERSPECTRAL IMAGING OF A COLD-WATER CORAL REEF (Abstract ID: 28373)

Cold-water coral reefs have a wide range of ecological functions. Large-scale mapping of the reefs is resource demanding. The standard method of visual seabed mapping today involves video transects and still imagery, which is a proven, yet time consuming and subjective method. A more robust and objective method is needed to improve the efficiency in benthic habitat mapping for better management. Underwater Hyperspectral Imager (UHI) utilizes high spectral resolution of the visible light reflected from objects on the seafloor to automatically identify Objects of Interest (OOI). A custom-made software including a spectral library containing optical fingerprints of a range of OOI's are used together with classification algorithms, for automated sea floor identification. The aim of this work was to demonstrate UHI-mapping of a coral reef and to optimize the classification algorithms for the reef-building coral *Lophelia pertusa*. Coral reefs in Norwegian waters was mapped with UHI mounted on a remotely operated vehicle. The two color morphs of live *L. pertusa* (white and orange), dead corals and associated fauna were identified. Maps of the distribution of the organisms are visualized in GIS format. Further, the reflectance spectrum of *L. pertusa* was measured in laboratory. Information on the variability of the spectral signatures are used to enhance the identification process. We propose that the UHI technology represents an efficient and high-quality tool for future environmental mapping and monitoring.

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CAN CORAL REEFS AND LARGE-SCALE DREDGING PROJECTS COEXIST? (Abstract ID: 28986)

Port expansion projects throughout the tropics have created a conflict between ports, environmentalists, regulators, and the public. Various reports from some projects show extreme impacts while others show little or none. Which is correct? Are there BMPs that can be employed to minimize impacts? When impacts do occur, are they expected and reasonable? And finally, can they be restored or mitigated? Using case studies, we highlight factors that work! The lessons learned from earlier projects show that the best course of action is the careful preparation and vetting of a pre-project environmental assessment that allows for a description and quantification of all anticipated impacts. This assessment should detail avoidance and minimization options as well as protective measures to assure for environmental permit compliance. During construction, quantitative monitoring of key biotic and abiotic parameters need to be performed so that corrective adaptive management measures can be employed mid-stream. It is imperative that monitoring programs carefully employ far-field controls for comparison. In addition, a spatially and temporally appropriate monitoring protocol should be employed to detect impacts in real-time. Finally, to make the public whole for any impacts, there is a need for restoration of injured resources and mitigation to offset those that are lost/displaced during construction. Through all project phases, open transparent communication between stakeholders is necessary to resolve conflicts between the various groups, many with disparate goals and interests.

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MODELLING AND MAPPING FISHING PRESSURE AND FISH STANDING STOCKS ACROSS MICRONESIA, AND ASSESSING THE POTENTIAL IMPACTS OF CLIMATE CHANGE (Abstract ID: 28495)

Reef fisheries are vital to Micronesian economies, but are threatened by over-exploitation and other stressors. As part of The Nature Conservancy's Mapping Ocean Wealth project, we assembled a database of 1127 fish surveys across five jurisdictions of Micronesia to model and map fishing pressure and current standing stocks. Using mean parrotfish size as an indicator of fishing pressure and controlling for biophysical gradients, we demonstrate that fishing is best predicted by distance to the nearest port and human population pressure within 200 km. This metric of fishing pressure and biophysical variables were then used to model standing stock. Standing stock increased with increasing oceanic productivity, upstream larval supply, depth, and coral cover, and decreased with increasing sea surface temperature and fishing pressure. The models were then used to predict fishing pressure and current standing stock across all reefs in the study area, providing the first continuous maps of these variables for Micronesia. Furthermore, we mapped potential gains in standing stock that might be obtained in no-take reserves by simulating zero fishing pressure. The ratio of current to potential standing stock also generated spatially explicit estimates of fisheries status and potential time to recovery. Finally, the models also provide insights into the impacts of rising sea surface temperatures that are expected to alter fish distributions and reduce body size. These maps and models are important regional resources to inform policy and aid protected area design and fisheries management.

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WHALE SHARK KINSHIP AND GENETICS: INVESTIGATING TWO POPULATIONS WITH DIFFERENT ECOLOGIES (Abstract ID: 29548)

Juvenile whale sharks are known to aggregate near coral reefs, usually due to high food availability, at several locations globally. A recent global study of whale shark population genetics has allowed for better understanding of genetic connections between aggregations in both the Indo-Pacific and Atlantic. This overview included an aggregation found within the Red Sea near Al Lith, Saudi Arabia; however, the Mafia Island, Tanzania, aggregation was not part of the study. The ecological behavior of these aggregations differs with the Saudi Arabian individuals showing strong seasonality, while acoustic telemetry data revealed cryptic residency at Mafia Island. Genetic analysis using microsatellite markers was performed on both populations, using a combination of primers sourced from previous studies and other newly developed primers to compare individuals within each population between seasons. The Red Sea population was compared between 5 seasons spanning 6 years from 2010-2015. The Tanzanian population was compared for 2 field seasons from 2012-2014. Genetic diversity was analyzed using allelic richness for 5 seasons in the Red Sea with no significant change seen. Contrasting to other whale shark aggregations allelic richness in the Red Sea shows no sign of reduction. Finally, kinship was analyzed for both aggregations, with two potential sibling pairs at the Tanzanian aggregation, but no possible sibling pairs within the Red Sea. This result suggests that the dissimilarity between the aggregations might not lead to differences in population relatedness.
http://Red_Sea_and_Tanzania_whale_sharks

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POLEWARD-SHIFT OF CORALS: TRANSPLANT EXPERIMENT OF JUVENILES FROM SUBTROPICAL TO TEMPERATE REEFS IN JAPAN (Abstract ID: 29426)

Recently, ocean warming causes poleward-shift or expansion of some corals from tropical/subtropical to temperate regions. In this case, coral larvae should be able to reach new locations and successfully settle, however no information is available on how tropical coral juveniles survive after settlement in temperate regions. Juveniles of many corals are known to acquire symbiotic algae, *Symbiodinium* from the environment. Establishment of symbiosis is important for the survival and growth of the early stage corals. However, in a poleward expansion situation, it is likely that the environmental symbiont community at the settlement location will differ from this in the original reef. Here, we examine the potential of subtropical coral juveniles to settle and initiate growth in a temperate reef in Japan. We used in situ transplant of acroporid corals to measure size and survival, and also genotyped *Symbiodinium* of the juveniles. The species studied are either known to be already expanding their distribution to the north or not. Interestingly, no major differences in survival and growth could be observed between expanding and non-expanding species 3 months after settlement. Symbionts of adult corals were all identical, whereas various types were found in juveniles from both locations and differed more between locations rather than between species. This confirms that coral juveniles acquire multiple symbiont types depending on the local environments where they settle and change over time instead of species-specific symbiont acquisition.

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DETERMINING THE HYDRODYNAMIC CONDITIONS REQUIRED TO DEPOSIT CYCLONE LINKED BOULDER DEPOSITS IN THE SOUTHERN GREAT BARRIER REEF (Abstract ID: 29366 | Poster ID: 389)

Cyclones are potentially catastrophic events for coral reefs that can result in widespread loss of coral cover and biodiversity. Large reef-derived boulders have been used to reconstruct the effects of extreme events on coral reefs and are crucial to our understanding of cyclone events on coral reef structural diversity, geomorphic change, and coral cover. Previous studies linking large coral boulders to cyclones often do not evaluate the specific hydrodynamic processes required to produce such deposits. This is an important knowledge gap since establishing a greater understanding of the hydrodynamic conditions required to deposit coral boulders will allow for more accurate predictions of coral reef change during high energy storm or cyclone events. In this study, we revisit boulders that have been linked to cyclone events on Heron and One Tree Reefs. The hydrodynamic conditions required to break, transport, and deposit the boulders on the reef flats were calculated by using a number of scenarios and transport models from previous studies of cyclone deposited boulders on coral reefs and rock platforms. We find that contrary to previous assumptions the boulders on Heron and One Tree Reefs could have been deposited during storm events on the east coast of Australia and do not necessarily require cyclonic conditions for transport and deposition. We also find the initial conditions of the boulder (e.g. attached or freely submerged) greatly influences this interpretation with attached boulders requiring waves generated by cyclones to be transported onto reef flats.

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PLANNING FOR THE FUTURE: INCORPORATING GLOBAL AND LOCAL SCALE DATA TO HELP MANAGERS PRIORITIZE CONSERVATION EFFORTS (Abstract ID: 28623)

Most managers seek to reduce reef vulnerability to climate change, but in the face of both global and local stressors, how should managers prioritize conservation efforts? We present one of the first examples of using a vulnerability assessment to prioritize efforts to reduce climate vulnerability. For twelve MPAs in Indonesia, we combined 1) state-of-art downscaled (4-km) climate model projections of bleaching conditions, 2) maps of anthropogenic stress, and 3) ecological monitoring data. These data cover both vulnerability components: exposure and resilience. In collaboration with local managers, we created a matrix of action options to aid in prioritizing conservation efforts. Sites that are high priorities have both low projected thermal stress and high resilience potential. At the other end of the scale are 'sacrificial' low priority sites that are already in poor condition and are projected to have high future stress. Between these extremes, our options matrix highlights and identifies specific sites where local conservation efforts are likely to have the biggest impact achieving specific MPA objectives. This is among the first vulnerability assessments to combine downscaled climate model projections with ecological monitoring data, an approach which can be replicated in other areas where managers face the familiar challenge of using limited conservation resources in the face of rapid global change and uncertainty. It is essential that local communities have the tools to easily and accurately assess tradeoffs in conservation efforts.

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THE ROLE OF MARINE PROTECTED AREAS IN THE REPLENISHMENT OF LOCAL FISHERIES (Abstract ID: 28137)

The precarious state of many coastal marine ecosystems has prompted the use of marine protected areas (MPAs) as a tool for management and conservation. However, the effectiveness of MPA networks is contingent upon our understanding of the processes that affect population dynamics. Since coral reefs are a naturally patchy and fragmented environment, the degree of connectivity between discrete populations is critical to the persistence of populations and by extension, the subsistence of local fisheries. We com-

pare observed patterns of larval dispersal over successive years for two exploited species of coral reef fish in the Keppel Islands, Great Barrier Reef. We combine parentage analysis with emergent analytical tools in graph theory to determine the consistency of larval export from a small network of no-take MPAs to nearby fished areas. Further, we test the old adage that bigger, older and fatter fish make the greatest contribution to the replenishment of fished populations, and provide empirical evidence for the relationship between fish size and local reproductive success. Our findings give important insight into the mechanisms shaping connectivity patterns in coral reef fish and the role of no-take MPAs in the replenishment of local fisheries.

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LARGE-SCALE MASS CORAL LARVAL RESEEDING ENHANCES CORAL RECRUITMENT FOR REEF RESTORATION (Abstract ID: 28587)

Scleractinian reef corals are foundation species on coral reefs but are increasingly threatened by chronic anthropogenic stressors interacting with natural perturbations, resulting in the degradation of coral and reef communities in many reef regions globally. Coral populations are naturally resilient through sexual reproduction and recruitment of juveniles and can recover from many natural disturbances given sufficient time and absence of large or chronic disturbances. However, where larval supply is limited, natural recruitment rates may be too slow or variable to restore coral populations within appropriate timescales, therefore active restoration processes need to be considered. Synchronous coral spawning events provide access to millions of larvae that can be used for mass larval rearing and settlement on degraded but recoverable reef areas. Most previous larval 'reseeding' studies have been done using small enclosures, whereas large-scale active interventions are needed to be ecologically meaningful. This study uses larger-scale mesh enclosures to contain millions of coral larvae after spawning during their embryo and larval development and subsequent settlement period on degraded reef areas in the northwestern Philippines. Use of large-scale mesh enclosures to rear millions of coral larvae combined with in situ settlement can significantly enhance initial settlement rates and stimulate coral recruitment on degraded but recoverable reef areas, thereby initiating reef restoration.

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CORAL REPRODUCTION AND RECRUITMENT ON A HIGH-LATITUDE REEF IN SOUTH AFRICA: RESILIENCE IN THE YOUNG? (Abstract ID: 29610 | Poster ID: 373)

The sexual reproduction and recruitment of corals, key processes in the maintenance and resilience of coral communities, are understudied on the marginal high-latitude reefs in South Africa. Furthermore, the impact of increasing water temperature and acidity on the early life stages of corals warrants investigation to establish how these corals may respond to predicted climate change. In this study, gravid colonies of two representative coral species, *Hydnophora exesa* and *Acropora austera* ,were collected from Two-mile Reef at Sodwana Bay (-27° S, 32° E) and spawned in the laboratory. Gametes were used to assess how increased water temperature and acidity (as predicted by the IPCC) would affect the fertilization, embryonic development, and recruit growth rates of these two species. Increased water temperature and acidity negatively influenced the early life stages of these corals, with changes in temperature having a greater effect than pH. However, fertilization and recruit growth still occurred under predicted climate change conditions. This study is the first to investigate the influence of increasing sea temperature and ocean acidification on the early life stages of corals on the high-latitude reefs of South Africa. Determining whether recruitment rates experienced during increased water temperature and acidity are sufficient to maintain reef resilience remains to be quantified.

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FISH ASSEMBLAGES ASSOCIATED WITH RED GROUPER PITS AT PULLEY RIDGE, THE DEEPEST PHOTOSYNTHETIC CORAL REEF IN THE CONTINENTAL U.S. (Abstract ID: 29421 | Poster ID: 188)

Pulley Ridge is a series of drowned barrier islands on the southwest Florida Shelf and is known to be the deepest photosynthetic coral reef in the continental U.S. The fishes at Pulley Ridge are unique in that they comprise a mixture of shallow water and deep species. With the majority of the ridge being low rugosity habitat comprised of algae and plate corals, fish densities are low compared to other mesophotic reefs. The exceptions to this are the pits which red grouper excavate throughout the area. These pits form high rugosity rock habitat which act as small biodiversity hotspots. ROV dives were conducted annually at Pulley Ridge from 2012 to 2015 to characterize grouper pits, examine their importance to the ecosystem, and determine the impact of lionfish invasion on their species composition. Approximately 66% of red grouper and 71% of lionfish observed were associated with a pit. Juveniles and small fish species were also associated with the excavations, particularly those that contained red grouper and/or lionfish compared to pits with neither species present. Lionfish and red grouper abundances both increased between 2012 and 2014 and then decreased in 2015 while abundance of juveniles and small fish displayed the exact opposite trend. PRIMER analyses also indicate that fish species assemblages were distinct among pits depending on red grouper and/or lionfish presence. Future analyses will compare fish assemblages from the current data with those conducted in 2008 & 2009, before the lionfish invasion, to examine the impact this species has on the ecosystem.

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MOLECULAR MODIFICATIONS IN CORAL REEF TAXA AND THE METABOLOMIC RULES OF COMMUNITY ASSEMBLY (Abstract ID: 28788)

Lipid-based molecules are fundamental building blocks of life on Earth. In addition to providing structure, lipids are involved in processes ranging from intracellular signaling to inter-organismal defense. Many physiological processes are activated by the enzymatic addition or removal of small molecules (e.g., acetyl groups) from lipids. This constant fluctuation in atomic composition of parent molecules gives rise to exceptional molecular diversity and reflects physiological changes within an organism, both of which we captured using a novel metabolomics approach. Metabolomes, comprised primarily of lipids, were extracted from 235 samples of benthic reef taxa. Samples were analyzed using liquid chromatography with tandem mass spectrometry followed by molecular networking to connect related molecules and identify modifications. Our data demonstrate that reef corals, sponges, tunicates, and algae exhibit distinct molecular modification capacities within and among taxonomic groups. In particular, taxa exhibit unique patterns of lipid methylation, acetylation, and phosphorylation. To better understand the ecological consequences of distinct modification capacities, we are determining how modification patterns are altered by benthic competition and whether these changes reflect competitive outcomes. The extent to which organisms differ in their capacity to modify molecules reflects the suite of functions they possess, thus our approach provides a robust way to examine whole-organism physiology within ecological frameworks such as the competition for benthic space.

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A RAPID, SIMPLE TEST FOR THE CORAL PATHOGEN VIBRIO CORALLIILYTICUS USING A SENSITIVE LATERAL FLOW "DIPSTICK" IMMUNOASSAY. (Abstract ID: 28781)

Vibrio coralliilyticus is a bacterial pathogen of both corals and shellfish larvae that is currently difficult to detect and manage. Commercial shellfish hatcheries are frequently experiencing dramatic losses due to vibriosis and we have developed a novel lateral flow immunoassay (LFA) that can detect V. coralliilyticus contamination in these rearing facilities. However, as the organism is also known to cause severe disease in corals and we are now exploring the possibility of utilizing this test as a coral disease diagnostic tool. The test is a rapid LFA that can measure extremely low levels of a protein toxic for corals and shellfish (the VcpA zinc-metalloprotease) secreted by V. coralliilyticus. We report here that the LFA test can measure VcpA levels as low as 5 ng/ml, which is 20-fold lower than the level of VcpA that causes noticeable mortality of shellfish larvae in the laboratory. LFAs are simple and easy to perform (home pregnancy test kits are common examples) and do not require any external instrumentation other than an eyedropper to apply several drops of sample to the sample port. Readout is visual and can be qualitative (plus/minus) or quantitative, as the signal strength is proportional to the amount of antigen present in the sample. We anticipate that this test will provide a useful tool for coral disease diagnostics as it provides real-time, on-site, early detection of bacterial presence.

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MICROBIAL PROCESSES IN THE SEDIMENT AT A SHALLOW-WATER HYDROTHERMAL VENT IN A TROPICAL CORAL REEF (Abstract ID: 28329)

Shallow-water hydrothermal vents occurring in tropical coral reefs are often used as analogs for future climate change scenarios. Hydrothermal venting can cause extreme physicochemical conditions, e.g. decreased pH and increased temperature, which may be detrimental to reef organisms. Given the importance of microbial processes in nutrient cycling on the reef, little is known about how these processes may differ in sediments subject to hydrothermal venting. Here we studied a hydrothermal vent system in Papua New Guinea, combining biogeochemical observations with metagenomic and metatranscriptomic sequencing of the microbial community in the sediment. Our results suggested changes in major element cycles (carbon, nitrogen, sulfur) related to hydrothermal venting. We detected a shift in the active photosynthetic community with a decrease in cyanobacterial and an increase in diatom gene transcripts. Net photosynthesis seemed to be negatively affected at the vent, presumably due to a trade-off between increased $CO_2$ availability and increased trace element stress. Furthermore, gene expression patterns suggested increased nitrification, whereas nitrogen fixation and denitrification to ammonia might be reduced. The composition of the sulfate reducing community was altered at the vent, and sulfate reduction rates and gene expression were severely diminished. We propose that hydrothermal activity in a tropical coral reef may drastically alter nutrient cycling in the sediment, potentially resulting in the degradation and simplification of such a diverse and complex system.

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FOLDSCOPE: AN ORIGAMI-BASED SOLUTION TO SCALABLE FIELD MICROSCOPY (Abstract ID: 28315)

Recent efforts in citizen science have shown that crowd-sourced wildlife observations can substantially contribute to our understanding of local and regional biodiversity. However, direct observations by citizen-scientists are usually limited to relatively large, macroscopic organisms, often neglecting the much larger range of species richness found at microscopic scales. This is because 1. microscopy is often viewed as an activity limited to scientists, and 2. microscopes are often expensive, fragile, and difficult to carry into the field. As a solution to these issues, we have developed the Foldscope: a rugged, ultra-low cost (<$1 in materials), origami-based microscope that is assembled by folding a pre-cut sheet of paper and can provide >400x magnification. Foldscopes can be operated independently of electricity, or they can be coupled to smartphone cameras to capture images and videos of live organisms while in the field. To date, we have manufactured and distributed 50,000 Foldscope units to participants in 135 countries (see their findings at https://microcosmos.foldscope.com), and Foldscopes have thus far been used to view organisms in a diverse range of settings including the Amazon rainforest, a tiger reserve (Kaziranga National Park) and major river (Brahmaputra River) in India, the Ngorongoro Conservation Area in Tanzania, and marine environments along the Pacific coast. Our aim is to provide a scalable tool such that any curious person in the world can explore his or her local microcosmos and broadcast his or her findings to a global community. http://www.foldscope.com

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ARE NOT SMALL PATCH REEFS WORTH MUCH MORE THAN A SINGLE LARGE CONTINUOUS REEF IN TERMS OF REEF FISH HABITAT? (Abstract ID: 27812 | Poster ID: 83)

Patchy habitats may enhance species coexistence through interspecific tradeoffs between dispersal and competitive ability. Hattori & Shibuno (2010) examined the species-area relationship of damselfishes over 84 patch reefs in a back reef of Ishigaki Island, Japan: a large reef harbored less species than small reefs of an equivalent area. Hattori & Shibuno (2013) found that interspecific competition was intense on large reefs. Hattori & Shibuno (2015) reported that the total volume of 3D reefs can be used to predict species richness. The present study assessed how to estimate 3D reef structure counting the host anemone *Entacmaea quadricolor*. Hattori & Kobayashi (2007) found the number of *Amphiprion frenatus*, which can be an indicator species of healthy back reefs, was highly correlated with the number of the hosts which in turn was highly correlated with the total area of reefs. A stereoscope was used to detect 3D reefs using high resolution aerial photographs. The total area of detected 3D reefs was not correlated with the number of the hosts, but the total area of reefs observed in photographs as dark colors was highly correlated with the number of hosts. Field observations revealed that dark colors indicated reefs (>0.5 m in height; 0.25 m in diameter), and the upper sections of large 3D reefs showed no dark colors (no corals). Thus, assuming that the number of hosts is the estimator of fish species richness, it is concluded that small patch reefs are worth much more than a single large continuous reef in terms of reef fish habitat, if the total area is equivalent.

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CURBING SEDIMENATION OF CORAL REEFS THROUGH COMPREHENSIVE STAKEHOLDER ENGAGEMENT; A CASE STUDY FROM FAGA'ALU, AMERICAN SAMOA (Abstract ID: 29212)

Although comprehensive stakeholder-engagement is recognized as essential for a holistic and effective approach to conservation, efforts often fall short in one sector or another. This presentation will share lessons learned from Faga'alu, American Samoa, a small Pacific island tropical watershed, where a collaborative ethos continues to push initiatives to curb sedimentation of coral reefs. Faga'alu's coral reefs demonstrate relatively high coral cover and serve as a critical habitat for a variety of marine species, including threatened species and organisms with cultural significance as a supplemental food source for subsistence fishing. In 2011, the community of Faga'alu developed a Village-based Conservation Plan, identifying sedimentation as a priority threat to their immediate environment. In response, a sediment budget study commenced, identifying the local quarry as the primary contributor. Five years later, Faga'alu has developed extensive private-public partnerships by leveraging federal assistance through its designation as a United States Coral Reef Task Force Watershed Partnership Initiative site and pursuing incentive-based approaches with the local quarry to reduce the introduction of sediments into the natural environment.

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PARTITIONING OF RESPIRATION IN AN ANIMAL-ALGAL SYMBIOSIS: IMPLICATIONS FOR DIFFERENT AEROBIC CAPACITY BETWEEN SYMBIODINIUM SPP. (Abstract ID: 28470)

Cnidarian-dinoflagellate symbioses underpin coral reef productivity. However, certain aspects of this symbiosis, such as the partitioning of respiration between animal host and algal symbiont, remain enigmatic. We quantified mitochondrial enzyme activity as a proxy for aerobic respiratory capacity in the symbiotic sea anemone Exaiptasia pallida. Host, symbiont, and combined host + symbiont (holobiont) mitochondrial citrate synthase (CS) activity were strong predictors of holobiont respiration. There was a positive association between symbiont density and host CS activity, and a negative correlation between host- and symbiont CS activities. We also found differences in symbiont CS activity between anemones hosting different Symbiodinium species (ITS2-type A4 Symbiodinium or Symbiodinium minutum [ITS2-type B1]). Notably, partitioning of total CS activity between host and symbiont, in both natural and re-infected E. pallida, differed from the respective host/symbiont biomass ratios. Moreover, the relationship between the partitioning of total CS activity and the host/symbiont biomass ratio was influenced by the specific identity of the symbiont. These data suggest that the long-held assumption of equivalency between symbiont/host biomass and -respiration ratios may lead to an overestimation of symbiont respiration, and erroneous conclusions regarding carbon budgets in these symbioses. Interspecific variability in symbiont aerobic capacity provides further evidence for physiological differences that should be considered when studying diverse cnidarian-Symbiodinium associations.

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DEVELOPING AN ASSESSMENT FRAMEWORK TO EVALUATE CORAL REEF CONDITION IN OFFSHORE MARINE PROTECTED AREAS (Abstract ID: 29848)

Cold-water coral reefs exist at all latitudes. Bottom fisheries, oil and gas exploration, mining, ocean acidification, and other human activities threaten them. The United Kingdom has discovered significant areas of these reefs and has in recent years actively designating Marine Protected Areas (MPAs). Sites are in deep water many miles offshore and are difficult to monitor so the availability of direct, observational evidence is currently relatively low. In the short-term, we require indirect assessment methods to undertake condition assessments so that regulatory authorities can be informed about the need for appropriate management measures. JNCC recently developed methods for assessing the likely impact of human activities on sensitive benthic habitats and species like Lophelia pertusa for

regional scale assessments. We have started to look at how these vulnerability assessments can be adapted to work at MPA scales, but also combined with indicators of health to provide an assessment of likely condition of these reefs. The evolving assessment framework incorporates a decision support tool that identifies options for the assessment of a particular reef depending on the type and amount of in-situ data available. A key aim of the tool is to record in a formal audit trail how a decision about reef condition was reached. These site scale assessments often need to consider cumulative pressures acting over the same spatial areas. Given this complexity, we need to be transparent in how we arrive at an assessment and in our level of confidence in the outcomes.

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LONG-TERM TRENDS IN BENTHIC COVER OF A HIGH LATITUDE REEF SYSTEM OFFSHORE SOUTHEAST FLORIDA, USA (Abstract ID: 29425 | Poster ID: 314)

The northern extent of the Florida Reef Tract (FRT) is a high latitude (>25° N) marginal system offshore southeast Florida (SEFL), USA. SEFL reefs are exposed to variable seawater temperatures and are adjacent to a highly developed mainland adding additional anthropogenic water quality and physical stress to the environment. This system is also unique in that it exists as continuous linear reefs rather than the often observed isolated, non-continuous patch reefs seen in other high latitude systems. In 2003 the Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP) was established as a northern extension of the existing Florida Keys program (CREMP). SECREMP provides long-term benthic cover data via annual image analysis of fixed sites along the upper FRT. This analysis focuses on the trends in benthic cover over the lifetime of the project (2003-2014) and the latitudinal gradient. Stony coral cover has remained relatively unchanged over the gradient through time, which is atypical compared to other systems throughout the Florida Keys, Caribbean and worldwide. Additionally, the reef community persists with a lack of extreme change in other major benthic taxa, such as sponges, octocorals and macroalgae. The lack of declining stony coral cover is a unique trend and suggests that this high latitude system, although possessing continuously low cover, is not experiencing the extreme decline of cover seen elsewhere.

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HIGH DENSITIES AND SELECTIVE FEEDING OF COTS THREATENS POST-BLEACHING RECOVERY OF CORAL REEFS IN NORTH-WESTERN AUSTRALIA (Abstract ID: 28903)

Successive, extensive bleaching events have reduced coral cover and altered species assemblages significantly in the Montebello and Barrow Islands in north-western Australia. In particular branching *Acropora* populations were dramatically reduced while massive coral forms such as portid and faviid corals were less impacted and now dominate coral assemblages. Subsequent to this perturbation, there have been changes in the abundance and/or distribution of the coral eating crown of thorns starfish (COTS), *Acanthaster planci* which have further impacted coral communities. We surveyed the Montebello and Barrow Island groups for COTS and documented coral cover throughout the region. The overall density of COTS was 8.9 $ha^{-1}$, but was as high as 186 $ha^{-1}$ in hotspots. The highest densities of COTS corresponded to the relatively small refuge areas where coral survival from the bleaching event had been greatest. We also studied the feeding preferences of COTS under post bleaching conditions to determine their likely impact on coral communities. We found that even when *Acropora* and *Pocillopora* were extremely rare, COTS demonstrated a preference these genera although they also consumed non-preferred taxa such as portid, faviid and merulinid corals in greater abundance. The consumption of non-preferred genera and families of corals was influenced by their local (between site) abundance. Where COTS populations exceed outbreak threshold densities they are likely to retard recovery of coral communities in this region.

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POTENTIAL DIAGNOSTIC MARKERS FOR SEVERAL FISH HYBRIDIZATION CASES (Abstract ID: 28640 | Poster ID: 36)

The development of molecular genetic techniques that generate taxon-specific markers to characterize individuals as pure species or hybrids and to document patterns of gene exchange and introgression is very important for hybridization studies. To investigate potential diagnostic markers, a suite of different primers for several nuclear genes were tested for several fish hybridization cases. The sequencing results from potential diagnostic markers were cross-referenced with the results from microsatellite data, RADseq data, and morphological data. The diagnostic consistencies were tested on purebred reference samples from large sampling spatial ranges. Combined with mtDNA data, the presence/absence of introgression and parental contributions for each hybridization case were considered as well. These potential diagnostic markers could serve as a quick test to discriminate species that may otherwise be ambiguous, could confirm putative hybrid cases between these species, and could even suggest the directions of introgression in closely related species. Once diagnostic markers have been confirmed, they provide a cheaper, faster, and less laborious approach (and require few fewer samples) than alternate methods such as microsatellites or next generation sequencing. A more detailed understanding of introgression and a more efficient confirmation of hybrids will facilitate a more general understanding of the role of hybridization in global biodiversity patterns.

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COMMUNITY STRUCTURE OF CORAL-ASSOCIATED FAUNA ON REEFS IN THE CHAGOS ARCHIPELAGO, CENTRAL INDIAN OCEAN (Abstract ID: 29539)

The majority of reef biodiversity is comprised of the cryptofauna, defined as small, often cryptic, mainly invertebrates, which inhabit the reef structure. Despite this the cryptofauna are understudied relative to fish and coral faunal components. Here we present an assessment of reef cryptofauna biodiversity (with a focus on the decapods, Crustacea) on dead branching corals, the most productive reef microhabitat, and we identify some key processes underpinning their community structure in the Chagos Archipelago. The Archipelago represents one of the most resilient reefs globally, partly because of its remote location away from the majority of human pressures. To assess decapod biodiversity we combined molecular and morphological identification techniques, allowing for a rare empirical evaluation of species delimitation methods, providing guidance for future studies. Whilst assessing decapod diversity an unanticipated high prevalence of obligate coral-dwellers were discovered on the dead coral microhabitats. Obligate coral-dwellers are almost universally found on live coral, inferring they have a strong reliance on live coral for food, habitat and/or recruitment. We examine potential biological reasons for this spill-over to dead coral microhabitats and whether these microhabitats may have a poorly known functional role in the life cycles of these species. These results add further complexity to our limited knowledge of the relationships between corals and the high diversity of motile invertebrates that inhabit live and dead colonies. These relationships are, however, fundamental to understanding the consequences of coral loss on species persistence and biodiversity.
http://www.zoo.ox.ac.uk/group/oceans/people/CH.html

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CONNECTING A RESEARCH INSTITUTION TO THE PUBLIC, BUILDING ON A 5 YEAR TIMELINE WHILE THINKING 7 GENERATIONS OUT (Abstract ID: 29180 | Poster ID: 716)

The Hawaii Institute of Marine Biology sits on an island, Moku o Lo'e, in a bay off of Oahu, Hawaii. Moku o Lo'e pre-contact history includes a cautionary legend about responsibility and sharing. In modern times it became part of multimillionaires' dreams of paradise, followed by desires to make a difference and donation of the island to the University (which has far less resources). In building our Community Education Program over the last six years, we have followed a few basic guidelines - be true to the island's history and look to the future for our community and research institution. We do not see these as separate. For our relatively new education programs at a research institute, we have considered how to make a positive impression on faculty and the community, as well as becoming fiscally stable on both 5 and 10 year horizons and from an indigenous perspective, thinking seven generations out. We describe our current offerings, as well as our next 5 year plan as it relates to the future.
https://www.hawaii.edu/himb/

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EFFECTS OF AQUACULTURE ON MUCUS PROPERTIES IN THE CORAL FUNGIA (Abstract ID: 29438)

South East Asian sea cage farms are often located within 1km from a reef. The cage farms release nutrients and on top of that, large quantities of antibiotics are used. The aim of this study was to investigate how these multi-stressor point sources impact coral mucus composition, the associated bacterial diversity, antibiotic resistance, and the anti-

biotic function of the mucus itself. We investigated the coral Fungia fungites mucus and associated bacteria in Nha Trang Bay, Vietnam. Coral mucus where sampled from eight sites along a gradient from sea cage farms. Total carbon, nitrogen, and phosphorous was measured. Coral mucus bacteria where isolated and genetically identified by sequencing the 16s rRNA gene. Furthermore, antibiotic resistance was assayed by the disc diffusion susceptibility test. We also tested the antibiotic activity in the coral mucus by growth inhibition tests. We found clear gradient effects with changed bacteria community composition, coral mucus NPC concentration and composition, antibiotic resistance, and antibiotic properties. Counterintuitive we found decreased concentrations of nutrients in mucus close to cage farms where the water is nutrient rich. The mucus also loses its antibiotic function when exposed to cage farming effluents. This will weaken the defence against bacteria and other pathogens. A combination of changed mucus nutrient composition and concentration together with lost antibiotic activity can be the explanation for changes in mucus bacterial composition and increased prevalence of coral diseases.

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UNRAVELLING FACTORS SHAPING INDIVIDUAL PERFORMANCE OF CORAL OFFSPRING: THE NEED OF A SELECTIVE APPROACH IN SEXUAL REPRODUCTION (Abstract ID: 28825)

During spawning events, millions of coral eggs and larvae are released into the water column to ensure reef persistence. However not all eggs and larvae created are equal and this variability among individuals may alter their efficiency to cope with a changing world. In this context, it is of paramount importance to select offspring with the best performance to environmental changes. Thus, we studied a) how parental effects (spawning behavior and thermal tolerance of adults) alter the larvae released and b) which larval traits may allow selecting the « winner » larvae. To do that, larvae of the corals Pocillopora damicornis were collected from « winner » and « loser » adults (to thermal stress) during different spawning days and months. Results showed that the parental thermal resistance of P. damicornis colonies has strong effects on the larva condition: bigger size, faster swimming speed, and better attraction to crustose coralline algae for larvae released from "winner" corals. Moreover larvae differ physiologically among the days they are released: late-release larvae being less competent than early-release larvae (slower swimming speed and lower thermal resistance). Finally green-fluorescent larvae displayed better recruitment and survival rate than red-fluorescent larvae. To conclude, our work underlined an important variability of the physiological and behavioral performances of coral larvae to face a warming world. This emphasized the need to develop a selective approach in sexual reproduction to enhance restoration efficiency in the future.

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USING ECOSYSTEM PROPERTIES TO DETECT TRANSITIONAL STATES IN CORAL REEF FISH ASSEMBLAGES (Abstract ID: 28901)

Ecosystem-based fisheries management requires the means to detect ecosystem change. Indicators based on single species, food webs, or subsets of the full community (e.g. biomass in a particular trophic group) have utility, but may not be sensitive to cumulative effects, or to variation in system level processes. System level indicators, such as those that relate to the distribution of energy across trophic levels, provide a means to identify whether a system is moving into or out of a state of disturbance or recovery. These cumulative biomass indicators have recently been shown to be robust and reliable for discerning ecosystem perturbation in > 100 different marine ecosystems. Therefore, integrative trophic level information appears to be a suitable entire-system indicator of global application. There is, however, uncertainty over how and to what extent these indicators are affected when there are large inputs of allochthonous nutrients, as is common in systems such as estuaries and coral reefs, thus limiting the utility of this approach to those systems. Here, we test the effect of allochthonous material on the accumulation of biomass across trophic levels in coral reef fish assemblages. We find strong differences in the basal biomass and trophic level inflection point (the point where maximum biomass is observed) in relation to background oceanic productivity, temperature and fishing pressure. By accounting for these natural environmental drivers, we can improve upon the utility of this system level metric as an indicator of human-induced perturbation for coral reefs.

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CHARACTERISING CORAL RESTORATION EFFECTIVENESS: A REVIEW OF CURRENT LIMITATIONS AND CHALLENGES AT A SOCIO-ECOLOGICAL SCALE (Abstract ID: 28268)

Coral reef restoration initiatives are burgeoning as the need for novel management strategies escalates to address dramatic declines in coral cover globally; however, coral restoration programs typically lack rigour and critical evaluation of their effectiveness. A review of 74 peer-reviewed papers using coral transplantation for reef restoration reveals that growth and survival of coral fragments were the most widely used indicators of restoration success, with 89% of studies using these two indicators either solely (51%) or in combination with a limited number of other ecological factors (38%). In 53% of studies, reef condition was monitored for one year or less, while only 4% of reefs were monitored for more than the recommended five years post-transplantation. These results highlight that coral reef restoration science has been focused primarily on evaluating the feasibility of techniques for coral restoration and the initial establishment phase post-transplantation, rather than longer-term community level outcomes. Here, we outline eleven socio-ecological indicators to comprehensively evaluate the effectiveness of coral reef restoration across the four pillars of sustainability. In summary, evaluation of the effectiveness of coral restoration programs should integrate ecological characteristics with socio-cultural, economic, and governance considerations to assess the efficacy of coral restoration as a tool to promote reef resilience and ensure the sustainable delivery of reef ecosystem services.

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HOLOTRANSCRIPTOME ANALYSIS REVEALS SYMBIODINIUM CLADE IDENTITY INFLUENCES CORAL HOST GENE EXPRESSION (Abstract ID: 30010)

Specific clades and subclades of the dinoflagellate symbiont Symbiodinium have been shown to affect the physiological response of their coral host to environmental conditions. However, little is known about the genetic underpinnings of these interactions. Here we use whole transcriptome sequencing and a system genetics approach to analyze gene expression in the coral Montipora capitata and its Symbiodinium symbionts from Hawai'i Island. In particular, we examined the effects of multiple factors on gene expression in the holobiont and its individual constituents, including collection site, presence of the coral disease Growth Anomaly (GA), and symbiont clade composition. We found that a large majority of colonies harbors only one clade of Symbiodinium, consistent across multiple marker genes. This pattern is unaltered by the presence of GA. Overall gene expression profiles and the number of differentially expressed genes revealed low to moderate differentiation between coral colonies affected and unaffected by GA and from different collection sites, respectively. Unexpectedly, we detected transcriptional changes with respect to Symbiodinium clade identity not only in gene expression of Symbiodinium, but also of the coral host. This suggests the symbiont influences its host at the transcriptional level. Network analyses revealed several modules of coexpressed genes in the holobiont and its consituents that are associated with clade identity, providing further opportunity to study the genetic architecture of this symbiosis.

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IMPACTS OF HABITAT DEGRADATION ON THE TROPHODYNAMICS OF CORAL REEF MESOPREDATORS (Abstract ID: 29003)

Mesopredators play a key ecological role on coral reefs, transferring energy from lower trophic levels to apex predators. Many mesopredator species also have great economic value in subsistence, commercial, and recreational fisheries. Despite their ecological and economic importance, there is a lack of understanding about how this functional group is affected by habitat degradation in coral reef ecosystems. As coral reef habitats are modified by disturbance, the prey fish community available to piscivores becomes altered. We show that mesopredators may be able to switch their diets to adapt to changing prey availability, feeding at a lower trophic level as food chains become shortened. Given this trophic adaptability and the longevity of many predatory fish, altered reef conditions may only affect their population sizes in the long term, yet impacts may

become evident sooner as a modification of the life histories of these species. We ask whether there are sub-lethal costs of habitat decline and changing prey availability, that may not be evident in the short term. Using stable isotopes, morphometrics, lipid analyses, histology and caging experiments, we investigate whether piscivorous coral reef mesopredators experience a loss of condition due to diminished energy reserves, resulting in reduced fecundity, growth and survivorship. Sub-lethal effects such as these can have a significant effect on mesopredator populations in the long term, with implications for reef fisheries, management and conservation.

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EXPANSION OF THE CORAL REEF EARLY WARNING SYSTEM (CREWS) NETWORK THROUGHOUT THE CARIBBEAN (Abstract ID: 29525)

The NOAA Coral Reef Early Warning System (CREWS) Network is a growing number of oceanographic and meteorological monitoring stations situated at coral reef areas of critical concern. The near real-time data from these stations are archived at NOAA and form the basis of daily ecological forecasts for coral bleaching, hydrodynamic events, and other marine environmental events of interest to environmental managers, researchers, and the public. The Network began over 15 years ago with NOAA funding as a station in the Bahamas, and grew to include stations in Puerto Rico, St. Croix, Saipan, and with other sources of funding, Jamaica and Little Cayman. However, storms and other realities resulted in the destruction or removal of all of those stations, excluding Little Cayman, which continues operating today as a new buoy design. A new collaboration between NOAA and the Caribbean Community Climate Change Center has resulted in the expansion of the network to include two stations each in Belize, Tobago, and the Dominican Republic, plus one in Barbados. Each of these sites has required collaborations among each country's environmental managers and agencies before agreement as to where to place the stations and as to who would be conducting maintenance. The second phase will include four to six new stations among these likely candidates: Antigua & Barbuda, Aruba, Bonaire, Cuba, Dominica, Grenada, Grenadines, Montserrat, San Andres, St. Kitts & Nevis, and St. Lucia & St. Vincent. http://www.coral.noaa.gov

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INCORPORATING THE MANAGEMENT OF CRITICAL ECOLOGICAL PROCESSES FROM SEAGRASS ECOSYSTEMS INTO THE SPATIAL MANAGEMENT IN A HIGHLY IMPACTED COASTAL SYSTEM (Abstract ID: 28515 | Poster ID: 630)

Ecosystems worldwide experience numerous stressors. However, the loss of key processes such as herbivory and predation can be particularly detrimental to overall functioning of an ecosystem. We examined the removal of algae by herbivory within seagrass beds, a key process in structuring these communities. The study aimed to determine the relative influence of herbivore abundance, the spatial arrangement of habitats, physico-chemical water quality variables and marine reserves on herbivory rates in seagrass beds. Herbivory rates were higher in seagrass beds that were suitable for the commercially fished rabbit fish Siganus fuscescens, with the abundance of this species being highly correlated with high levels of herbivory. A species-distribution model to determine areas of high importance for this species, and thus herbivory, suggested that temperature, salinity and seagrass bed size were all positively correlated with the abundance of this species. Our results highlight the importance of understanding herbivory in the management of highly impacted ecosystems, emphasizing how fragmented seagrass beds and poor water quality can diminish the significance of herbivory that occurs within seagrass ecosystems. Fragmentation and poor water quality not only drive decreases in key processes in seagrass, with similar issues facing inshore coral reefs. An ecosystem wide approach is needed to reduce the impact of increased sedimentation on both seagrasses and coral reefs in highly impacted coastal systems.

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ARE NET CALCIFICATION AND ISLAND VERTICAL ACCRETION RATES OF THE NORTHWESTERN HAWAIIAN ISLANDS KEEPING PACE WITH RISING SEA LEVEL? (Abstract ID: 29850)

The rising atmospheric and hence surface ocean pCO2 is forecasted to alter rates of calcification and dissolution of coral reef ecosystems globally. Much of what is known about marine CO2-carbonic acid system chemistry is based on either analysis of open ocean waters or intensive characterizations of specific reefs on a small spatial scale. However, analysis of coastal ocean reef systems is lacking. In particular, whether the accretion rate of low lying coral atolls and islets can outpace the projected sea level rise is unknown. Four years of carbon system data were analyzed to characterize the net calcification of the reef ecosystem of the Northwestern Hawaiian Islands in the Papahānaumokuākea Marine National Monument (PMNM). Discrete bottle samples (n=1073) were collected via CTD hydrocasts (n=275) to measure alkalinity and pH from nearshore transects along the 1,500-mile archipelago. A consistent and significant mean alkalinity deficit between 3.4 and 32.8 µmol/kg (compared to open ocean waters) was detected up to 7.0-23.4 km from emergent land with a significant latitudinal trend. At French Frigate Shoals, the spatial characteristics of the alkalinity deficit, bathymetry, surface currents (HYCOM), and island density proxies were used to calculate net CaCO3 production and island platform vertical accretion rates. These results provide vital insight into whether these islands will outpace sea level rise and plate subsidence and will determine the viability of this critical nesting and rearing habitat for endangered/threatened monk seal, sea turtle, and seabird species.

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KULIA MARINE SCIENCE SCHOLARS CLUB - BUILDING CAPACITY WITHIN OUR LOCAL HIGH SCHOOLS FOR CORAL REEF SCIENCE (Abstract ID: 28976 | Poster ID: 715)

The KULIA Marine Science Scholars program is a unique High School after-school club program that builds capacity at the HS level by engaging and training local students in coral reef science through the school year, then encouraging them to pursue additional training during the summer via our various partners and colleague's summer intensive programs. Funded by a Native Hawaiian Education grant and funds from the Smithsonian Institution, the program links under-served students from local schools to current research efforts at the Hawaii Institute of Marine Biology/University of Hawaii-Manoa. The program will ultimately have our High School level students assisting in long term data collection for a Smithsonian coral reef monitoring site (MarineGEO), as well as having them collaborate with H.S. students from other sites nationally and internationally on projects. It is part of a culturally appropriate, linked system we are building to provide our local students with pathways into science and reef management careers by using the cutting edge tools our researchers are using, including 3-d video imaging, e-DNA, ARMS and biofilms assessments. By creating a program that extends and supports our colleagues' training efforts, we all become more attractive for private and government funding streams.

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CORAL BLEACHING IN RAPA NUI: ENSO-RELATED? (Abstract ID: 29956 | Poster ID: 319)

Coral reef ecosystems of isolated islands and high latitudes offer unique opportunities to study effects of seawater temperature anomalies. Rapa Nui (Easter Island) is the southeastern most island and coral reef habitat in the Pacific Ocean, where seawater temperatures normally range between 20 and 25 °C. In this study, we quantify coral bleaching in Rapa Nui coincident with the 2015 El Niño Southern Oscillation (ENSO), when seawater temperatures were 1.0 °C higher than maximum monthly means for the region. We quantify coral cover and bleaching for four sites and two depths (10 and 15 m): Anakena (north), Manavai (west), Motu Nui (southeast), and Vaihu (southeast). The mean percent cover of coral was 77.1% (68.3 – 89.7%) and did not differ significantly by depth or site. *Porites lobata* was dominant at Anakena (77%) and Manavai (83.4%), while *Pocillopora* spp. was dominant at Motu Nui (69.8%) and Vaihu (66%). The mean percent cover by bleached coral was 84.9% (73.1 - 94.6%) and differed significantly among sites but not between depths. Most corals were pale and partially bleached rather than totally bleached. Corals in Rapa Nui bleach near 26.5°C during La Niña and El Niño events. Despite Rapa Nui's sub-tropical location, high wave energy, and extreme isolation and, coral abundance is relatively high. Future research in this region should examine recovery from bleaching and changes in benthic composition.

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EXPLORING CORAL-ASSOCIATED BACTERIA OVER AN EXTREME DEPTH GRADIENT: ASSESSING THE PRESENCE OF UBIQUITOUS SYMBIONTS (Abstract ID: 29157)

Bacteria have an important functional contribution to the health, nutrition, and nutrient cycling of coral reefs, yet almost nothing is known about the bacterial and microbial communities of corals in the mesophotic zone. Coral-associated bacteria are responsive to coral host habitat and the high observed variability of coral-bacterial interactions has lead to the hypothesis that there are only a few ubiquitous bacterial symbionts. We assessed bacterial communities from shallow down to lower mesophotic depths (0-80 m), using this steep environmental gradient to test the ubiquity of specific bacteria interactions in corals. Utilizing 16S rRNA amplicon sequencing on the Illumina MiSeq platform, we conducted an exhaustive characterization of the coral bacterial community in three dominant depth-generalist coral species (*Pachyseris speciosa*, *Acropora aculeus* and *Mycedium elephantotus*) from nine reef locations on the Great Barrier Reef and the Coral Sea (n = 312). We identified a range of ubiquitous bacteria along the depth gradient and spatial scales, suggesting the existence of permanent and stable coral-bacteria symbioses across reef environments. Nonetheless, mesophotic corals showed persistent bacterial communities different in richness compared to shallow corals, supporting the argument of habitat partitioning and ecological diversification over depth. The identification of ubiquitous bacteria highlights important candidates for in-depth functional studies regarding their role in the health and survival of scleractinian corals under a wide range of environmental conditions.

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CHARACTERISTICS AND DRIVERS OF CORAL-REEF FISHERY LANDINGS IN POHNPEI, FEDERATED STATES OF MICRONESIA (Abstract ID: 28386 | Poster ID: 556)

Island societies are reliant upon sustainable coral-reef fisheries for food and ecosystem services. Pohnpei is typical of many small island nations in that evidence points towards unsustainable harvesting regimes over the last decades. Yet, species-level monitoring of fisheries landings remains rare despite their fundamental need for improving management. Extensive sampling of landings coupled with socioeconomic surveys of commercial fishing activities provided new insights into Pohnpei's reef fisheries. Pohnpei's commercial landings were dominated by only a few species, the use of nighttime spearfishing, and by a small community of fishers. These characteristics suggest a strong, targeted economic reliance currently exists for a few species by a subset of fishers. Further, strong dependence was found between fishing success, and catch composition, upon favorable fishing conditions associated to conditions of low wind/swell and moon illumination. Catch trends also mirrored ecological trends from long-term monitoring efforts, as reef conditions were previously predicted by fish assemblage structure, which was most favorable on the windward side of the island with least fishing access. Several fisheries policies have been developed in Pohnpei in recent years yet, enforcement and compliance remains challenging. Available datasets suggest limited impacts of management to date. Our findings provide an improved foundation for tailored outreach and enforcement actions that would maximize returns given challenging resources limitations.

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CORAL REEF FISH POPULATION DYNAMICS: A STUDY CASE OF CONNECTIVITY PATTERNS IN PROTECTED AND UNPROTECTED MARINE AREAS. (Abstract ID: 29500)

Connectivity among marine populations is a key element to metapopulation dynamics and species persistence in fragmented habitats. We explored the influence of connectivity on population and metapopulation growth rates for a fish species, Abudefduf saxatilis, in some protected and unprotected reefs in an upwelling area at the South Caribbean. We assessed the demographic effects of connectivity patterns, empirically parameterized, using stage-based matrix models coupled with connectivity matrices. Quantitative metrics and local population explorations were used to quantify the connectivity value of individual reefs in the metapopulation. We found that population dynamics were highly variable with the upwelling cycle phases. The highest population and metapopulation growth rates occurred when calm and weak upwelling events took place. Local populations at marine protected areas, with highly complex habitat and coral cover, emerged as source populations and were identified as the most valuable reefs within the metapopulation in terms of connectivity. Elasticity analyses suggest that adult survivorship has the greatest influence on population growth at low levels of connectivity, although this influence decreases as levels of connectivity increase. The relative importance of vital rates on the resulting population growth rate also depends on the levels of population connectivity. Our results confirm the importance of spatial and temporal connectivity patterns among networks of protected and unprotected marine areas for the maintenance of coral reef fishes on time.

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THE UNLIKELY PERSISTENCE OF RESTORED STAGHORN CORAL (ACROPORA CERVICORNIS) POPULATIONS IN A WARMING WORLD: LESSONS LEARNED FROM A MODELLING APPROACH (Abstract ID: 28802)

Low-tech coral propagation has become critical for the recovery of depleted populations. But little is still known about restored population demographic dynamics in response to recurrent acute disturbances such as massive bleaching and disease outbreaks. Stochastic modeling was used to address on a 2-year old restored population of Staghorn coral (Acropora cervicornis) in Puerto Rico the impact of the 2005 massive coral bleaching and simultaneous white band disease and shutdown reaction outbreak. An initial cohort of 105 colonies of three size stages (<25 cm, 25-100 cm, >100 cm) was out-planted and monitored between 2003 and 2005. Three independent matrices were analyzed based on disease prevalence: 1) low disease (<7%); 2) high disease (36%); 3) massive bleaching + high disease (78%). In the absence of continuous input of new fragments to the restored population, even under low disease prevalence, the population will go into extinction within less than a decade. But adding 1,000 + Nt+1 small colonies each year will improve abundance from 1,000 in t=0 to 35,980 in 25 y, even under recurrent bleaching and disease events. When adding the same amount of medium colonies, abundance increased to 51,382 in 25 y. Elasticity analysis showed that in the absence of major disturbance survival of small colonies is critical. But under disturbance, survival of medium colonies becomes the critical stage. This suggest the importance of maintaining a continuous supply of medium corals to restored populations in order to maintain a dynamic stability under current ocean warming trends.
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INCIDENCE OF SCUBA DIVING AND CARRYING CAPACITY OF DIVE SITES AT JARDINES DE LA REINA NATIONAL PARK, CUBA (Abstract ID: 27808 | Poster ID: 567)

Contemplative diving is one of the main tourist attractions in the Jardines de la Reina National Park (PNJR), located off the southern coast of the provinces of Sancti Spiritus, Ciego de Avila and Camagüey. A study was conducted to determine the effect of this activity on the coral reefs of the area, particularly on stony corals. 28 sites were surveyed during a ten-day period and areas with high, medium, low diving intensity and with no diving were compared taking into account the percentage of stony coral cover. 220 line transects were used and 51 divers were observed. In sites with high diving intensity, 36 species of stony corals were identified. The most representative species were S. siderea, A. agaricites, P. astreoides, M. alcicornis and O. faveolata. Of the 51 divers observed, 48 violated diving regulations by making contact with the corals. Suspensions of sediments and to a lesser extent, mechanical damage (breaking of organisms) were also among the negative effects of the activity. Gorganians, followed by stony corals, were the most contacted organisms. The amount of touches per diver was 5,8/minute. Effective carrying capacity in Jardines de la Reina ranged from 15 to 35 divers/site/day. The surveyed sites showed no signs of deterioration in spite of the impact of recreational diving recorded on the said sites. However, monitoring of affected organisms to follow up post-damage evolution and the compliance with the number of divers/site/day suggested in this study is recommended.

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THE INFLUENCE OF THERMAL HISTORY ON CORAL BLEACHING RESPONSE DURING HIGH TEMPERATURE STRESS (Abstract ID: 28253)

Thermal history has been identified as a key factor for coral reef resilience. The National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Watch (CRW) has developed a suite of Thermal History products for reef locations based on the 28-year (1985-2012) Pathfinder satellite sea surface temperature (SST) dataset. The spatial resolution is 1/24° (~4 km), enabling reef-scale examination of spatial patterns. Products are described within six themes: 1. Trends (SST rates of change); 2. Climatology (long-term average conditions); 3. SST Variability (warm season & annual); 4. Annual History (maximum SST, anomaly, and accumulated thermal stress, by year); 5. Stress Frequency (number of events for different stress levels); and 6. Onset Timing (expected onset & variability). Images and data layers for this product suite are publicly accessible on the CRW website. These provide managers and reef stakeholders a detailed understanding of spatiotemporal changes in historic exposure to thermal stress and temperature variability. Of more than 60,000 reef pixels globally, 97% have shown positive SST trends with 60% warming significantly. Bleaching-level stress occurrence increased three-fold globally, but varied regionally. Example links between thermal history and observed bleaching will be described to offer insight into how these products can be applied to identify resilient reefs. Such research efforts have myriad applications in marine spatial planning as the current global coral bleaching event creates opportunities to contrast thermal history with bleaching severity.
http://coralreefwatch.noaa.gov/satellite/thermal_history/

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THE ROLE OF SOMATIC MUTATIONS IN THE ADAPTIVE EVOLUTION OF A SCLERACTINIAN CORAL IN RESPONSE TO ACIDIFICATION STRESS (Abstract ID: 28771)

The capacity of coral reefs to adapt to environmental changes has been a hot topic over the last decades. The speed at which corals adapt might be too slow to keep up with these changes. However, this only considers selection on the genetic variation that is passed from one generation to the next. Here, we investigate the potential role of somatic mutations in the evolution and adaptation of a scleractinian coral under future ocean acidification conditions. A single clone of *Stylophora pistillata* has been maintained in the aquarium system of the Centre Scientifique de Monaco since 1989. Samples were taken from multiple colonies as well as from replicate nubbins subjected to different pCO2 treatments (pH 7.2 and 8.1) for four years. All samples were genotyped using RAD sequencing. Two different restriction enzymes were used so that independent data sets could be obtained for each sample. This approach allows us to identify PCR duplicates and produces long sequencing reads, thus increasing the number and fidelity of identified polymorphisms. With these data we aim to (1) discover SNP markers for the identification of somatic mutations, (2) estimate the frequency at which they accumulate over time, (3) determine how they contribute to genetic variation within and between colonies, and (4) to determine if somatic mutations play a role in the evolutionary adaptation of corals. Results of this study will provide us a better understanding of the adaptive significance of somatic mutations in corals when coping with rapid environmental changes such as ocean acidification.

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DRIVERS OF LIONFISH DISTRIBUTION ACROSS BROAD SPATIAL SCALES IN CARIBBEAN CORAL REEFS (Abstract ID: 28889)

Lionfish is recognized as the most damaging invasive species in Caribbean reefs causing ecological and socio-economic impacts. Yet, drivers of its abundance and spatial distribution are under debate, hampering progress towards diminishing its threat to the region's reefs. Here, we explore the broad-scale patterns of lionfish abundance to understand the importance of habitat structural complexity, coastal development, overfishing, marine based pollution, sedimentation and protection status on the fish distribution. Lionfish abundance was estimated using photographic records collected along 2,300-m2 belt transects in eight countries across Caribbean. These results will support matrix models to explore the contribution of extrinsic factors to the overall growth of local. In summary, lionfish distribution was spatially heterogeneous and highly clustered, implying controlling mechanisms acting on their spatial distribution. Results suggest that degradation due to anthropogenic stressors could be facilitating the establishment of this invasive opportunistic species, while marine protection status down regulates the fish abundance. The potential role that environmental scenarios have on interconnected populations is here discussed in terms of management prioritization for resource exploitation. Our results confirm the region-wide and spatially variable distribution of lionfish, highlight the potential role of anthropogenic drivers and MPA on the distribution patterns of this species and provide evidence that local control efforts may be effective for managing lionfish populations.

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DRIVERS OF REEF SHARK MOVEMENT: WHAT'S MOST IMPORTANT? (Abstract ID: 28284)

Predator presence has been reported to influence the movement and behaviour patterns of prey species in various ecosystems. The movement of predators is thus key to the behaviour patterns of prey populations and defining their corresponding movements. However, the drivers of movement patterns in predators are much more difficult to define, especially in aquatic environments. Here we explore the movement patterns of reef sharks as a case study in drivers of marine predator movement. Long-term acoustic telemetry data collected from reef sharks (grey reef, blacktip reef, silvertip, tiger and bull sharks) within the Great Barrier Reef over a five year period were examined to determine potential drivers of movement. Telemetry data revealed complex movement patterns of reef sharks that vary by size, sex, species and habitat type. Some of the common drivers for coastal species, such as environmental conditions, appear to be irrelevant to most reef shark movements. This indicates biological drivers are more important in the movement patterns of these individuals. This talk will consider the importance of various drivers of reef shark movements and the implications of these drivers for defining ecosystem dynamics and within the context of conservation management.

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LINKING COMPLIANCE AND ECOLOGICAL OUTCOMES IN A MARINE PROTECTED AREAS NETWORK: A CASE STUDY IN THE BIRD'S HEAD SEASCAPE (Abstract ID: 27852)

The general scientific consensus is that establishment of a network of Marine Protected Areas (MPAs) could mitigate coral reef decline and maintain biodiversity and sustain fisheries. The importance of compliance with MPA regulations has been highlighted, but studies on the relationship between ecological performance and enforcement effort in MPA networks remain limited. In the Bird's Head Seascape of the Coral Triangle, which supports highest coral reef and reef fish biodiversity in the world, local community, governments and partners developed a network of Marine Protected Areas (MPAs). In efforts to promote compliance with MPA regulations, enforcement efforts have evolved from 2007 to the present, becoming more structured and better designed. In parallel, large scale ecological monitoring was developed and implemented periodically, focusing on changes in hard coral mortality, cover, and morphology, and fish abundance and size of different trophic groups. Initial results indicate that ecological performance varies among MPAs with stable, increasing and decreasing trends all present. Further analyses investigating the relationship between the enforcement efforts and ecological changes provide insights into promoting compliance in this MPAs Network.

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COLD STRESS RESPONSES OF TEMPERATE ZONE CORALS (Abstract ID: 28433)

The distribution of corals in Japan covers a wide range of latitudes, encompassing tropical to temperate zones. However, coral communities in temperate zones contain only a small subset of species. Among the parameters that determine the distribution of corals, temperature plays an important role. Rising temperature has resulted in a poleward shift/expansion of corals' distribution in Japan (Yamano et al., 2011). We tested the resilience to cold stress of three coral species belonging to the genus *Acropora* in incubation experiments. *Acropora pruinosa*, which is the northernmost of the three species, bleached at 13°C, but recovered once the temperature was increased. The two other species, *A. hyacinthus* and *A. solitaryensis*, which have a more southerly range, died rapidly after bleaching at 13°C. The physiological effects of cold bleaching on the corals included decreased rates of photosynthesis, respiration, and calcification, similar to the physiological effects observed with bleaching due to high temperature stress. Contrasting with hot bleaching, no increases in antioxidant enzyme activities were observed, suggesting that reactive oxygen species play a less important role in bleaching under cold stress. These results confirmed the importance of resilience to cold stress in determining the distribution and northern limits of coral species, as cold events causing coral bleaching and high mortality occur regularly in high latitude zones.

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FOCUSING ON THE FOUNDATION: EARLY STAGES OF DATA GENERATION AND MANAGEMENT (Abstract ID: 28341)

Data managers are responsible for data management plans, ensuring projects adhere to established policy, and maintaining data portals for data distribution and archiving. However, there is a front end of data management that is just as important and often overlooked, the early stages of data generation. This includes planning, field data collection, data entry, and data assurance processes. We focus on this early stage of the data management lifecycle and highlight the importance of being involved on the frontlines of data management. Today's coral reef ecosystem monitoring programs leverage resources among partners to efficiently implement field surveys. In large jurisdictions these programs may consist of many field personnel from numerous agencies, organizations and institutions. It is increasingly important to understand the impacts to data organization and quality associated with a large team, and it's critically important from a logistical standpoint to ensure the monitoring is implemented according to protocol and delivered according to the data management plan. This person will work with partner managers and scientists in the field and follow the data lifecycle through quality assurance checks, concluding with data delivery to the data steward or other data managers. Lessons learned from simple and complex monitoring programs are addressed along with suggested guidelines for best practices to streamline the data management process.

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REDUCING ECOSYSTEM EFFECTS OF COMMERCIAL FISH TRAP FISHING (Abstract ID: 29797)

Fisheries can have unintended effects, particularly in highly integrated coral reef ecosystems. Bottom tending gears can affect benthic habitat characteristics, and the removal of non-target species can disturb ecosystem processes. To examine effects, this multiyear, multifaceted research used observer trips, port samples, and trip tickets to document the species composition and quantities of bycatch by gear from St. Thomas commercial fisheries (U.S. Virgin Islands). High catches of ecologically important species, particularly herbivorous fishes known to assist corals in their competition for space, encouraged further study of ways to reduce bycatch in fish traps. Cooperative research, combining scientists and commercial fishermen, examined vent size, placement, and number per trap. Well-designed escape vents proved an effective means to increase size selection for key target species (e.g., *Epinephelus guttatus* – increased mean catch length by 5 cm TL) and to reduce bycatch and bycatch mortality of herbivorous species (from 20-90%). Expanded use of escape vents throughout the commercial trap fisheries of the USVI is underway with the potential to benefit corals and the integrity of the coral reef ecosystems.

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THERMAL STRESS, BLEACHING AND CARBON FATE: A METABOLOMICS APPROACH (Abstract ID: 28031)

Major gaps remain in our understanding of how symbiont metabolic function (mobile product translocation) responds to thermal stress and bleaching, yet this exchange is critical for symbiotic cnidarians. Our study applied stable isotope tracers ($^{13}$C bicarbonate) coupled to gas chromatography-mass spectrometry, to trace the fate of photosynthetically fixed carbon (individual compounds), during thermal stress and bleaching. To this end, we applied a model symbiosis (*Aiptasia-Symbiodinium* ITS 2 type B1) and a common Pacific coral (*Acropora aspera* dominant *Symbiodinium*ITS 2 type C3). Our data uncovered clear metabolic and cellular responses to thermal stress and bleaching in both symbioses, in terms of both the quantity and composition of the labelled free metabolite pool. Primarily, changes associated with alterations to lipid metabolism and non-enzymic antioxidant mechanisms. Most interestingly however, even with advanced thermal stress and bleaching, we observed significant fixation of carbon, biosynthesis of labelled organic products and translocation to the host (primarily as glucose). These data suggest that even during severe episodes of thermal stress and bleaching, remaining *in hospite* symbionts may be metabolically functional, in terms of their continued provision towards host metabolism. These data therefore have implications for our understanding of the cellular and metabolic changes that occur during symbiosis dysfunction during thermal stress and bleaching.

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ADAPTATION OF TROLL FISHING EQUIPMENT AND METHODOLOGIES FOR USE IN TOWED UNDERWATER SENSOR PLATFORMS (Abstract ID: 29950)

Towed underwater platform systems such as Teardrop (ICRS 2012) are being used with high-resolution video cameras to map out underwater terrain and monitor coral reefs. The use of cameras in the mapping method requires that these towed underwater platforms be stable as they are being towed and require the ability to control tow depth and offset in order to access areas that need to be surveyed. In this paper we explore the adaptation of commercial troll fishing equipment and methods to create a system that provides a stable underwater platform whose tow path depth and offset can be controlled. The system is composed of a typical troll fishing setup such as a rod, a reel, tow line, appropriate trolling devices and a specially designed "Towpedo" which acts as the towed platform designed to carry the sensor package. The trolling devices utilized in the system are (1) divers designed to control and maintain tow depth and (2) planer boards designed to control the tow path offset from the towing vessel. The Towpedo is designed for stability and houses sensors internally such as a video camera for image mosaicking and mapping. The system as a whole provides advantages over existing towed underwater platform systems in terms of stability, resistance to wave action, tow path depth and offset control, portability, scalability to tow an array of towed platforms from a single towing vessel, allows for operations in shallow waters where tow vessels cannot directly traverse and the towing in deeper waters where existing systems are limited.

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PROBLEMS IN CAPTURE FISHERIES IN RAGAY GULF, PHILIPPINES: COST OF INACTION (Abstract ID: 28992 | Poster ID: 575)

The status of fish stocks in Ragay Gulf, Philippines was assessed using catch and effort monitoring, experimental fishing and gear-fisher inventory. Results show catch rates of 8 of 13 gears decreased 48 to 98% between 1995 and 2006. Catch composition shifted from more-valued species to lesser-valued. Six of 8 top species are exploited way below their size at first sexual maturity. The condition of demersal fish stocks decreased 45% during the same period. The problems in capture fisheries in the gulf include high fishing pressure, intense competition for fishing grounds between municipal and commercial fishers, deteriorating habitat quality and lack of political will to enforce the law. Projections of catch biomass can increase 3x with a corresponding 4x increase in monetary value if fish were allowed to grow to maturity before they are captured. Schemes to achieve profitable fishing schedules in the area and important strategies such as market denial schemes and self-policing members of fishing cooperatives are explored to improve fishing practices in the area are discussed.

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WATER QUALITY AND HEALTH OF CORAL REEFS (Abstract ID: 28013 | Poster ID: 424)

Coral reefs are the "rainforest of the sea" and are economically and ecologically valuable resources (Swart, 2013). Corals have experienced significant decline worldwide likely due to anthropogenic pollution, invasive species, climate change, and abnormal weather phenomenas (Hendee et al., 2001; Santavy, 2011). This study aims to fill in this gap in the literature and estimates the impacts of degraded water quality parameters and warmer climate on coral reef abundance in the Florida Keys National Marine Sanctuary (the Keys). ArcGIS geospatial analysis tools combined witg statistical regressions; were employed to identify the effects of elevated inorganic nutrients, turbidity levels, and temperature on coral abundance. Regression results indicate that enhanced levels of nitrite and nitrate combined significantly reduce total coral coverage in the Keys. Initially, elevated level of silicate enhances the abundance of corals, however excessive levels result in significant decline in coral coverage. Our results also show that the increased turbidity are associated with low coral coverage. Stony corals exhibit more sensitivity to nutrient pollution, however both corals remain sensitive to warmer climate and increased turbidity. These effects are likely more severe in unprotected areas. Regarding policy making related to the Keys Marine Sanctuary, this research suggests that management efforts geared towards efficient water pollution control can significantly enhance coral reef abundance in the Keys.

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COUPLED BIOGEOCHEMICAL AND HYDRODYNAMIC MEASUREMENTS OVER A PALAUAN SEAGRASS BED: CAN SEAGRASSES MITIGATE LOCAL ACIDIFICATION STRESS? (Abstract ID: 29001 | Poster ID: 102)

Interest in seagrass beds as a tool to locally mitigate ocean acidification is growing rapidly. Much of the interest in seagrasses is motivated by their root structure, which is able to sequester carbon over interannual and longer timescales. Far less is known about their biogeochemistry over shorter diel timescales, yet we know that diel cycle variation in CO2 chemistry on coral reefs can be substantial. Understanding short-term seagrass biogeochemistry is critical to evaluating if, and how, seagrasses may eventually be utilized to mitigate OA on coral reefs. We present the results of a high-resolution, 24-hour control volume experiment conducted along a 50m x 100m seagrass bed in the Republic of Palau. Our dataset includes diel cycles of hydrodynamic (current profiles and turbulence), biogeochemical (pH, pCO2, TA, DIC, and O2), and environmental (temperature and salinity) parameters. We use these coupled hydrodynamic-biogeochemical measurements to estimate ecosystem metabolism and to better quantify the capacity of seagrass to alleviate local acidification stress through the photosynthetic uptake of CO2. Combining our field observations with box model predictions allows us to gain insight into the mechanisms that control seagrass metabolism and their potential to buffer CO2 for downstream corals.

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GLENN ALMANY'S CAREER IN REEF FISH ECOLOGY, CONSERVATION, AND FISHERIES: FISH COMMUNITIES, CONNECTIVITY, AND COMMUNITY-BASED MANAGEMENT (Abstract ID: 28199)

Despite his career being cut tragically short, Glenn Almany was a world leader in the ecology, conservation, and management of coral-reef fishes. Completing his BS at San Francisco State in 1996, he entered Mark Hixon's lab at Oregon State with an NSF predoctoral fellowship. He completed his PhD in 2002, publishing 6 papers in top journals. Glenn's novel field experiments showed that prior residents have strong effects on subsequent colonization of patch reefs. With lab mate Michael Webster, he also explored the intense early post-settlement mortality suffered by reef fishes. Glenn received a Fulbright Postdoctoral Fellowship in 2003 to study at James Cook Univ, where he began work with Geoff Jones and colleagues on larval connectivity. He was instrumental in developing and applying new methods to track larval dispersal in pelagic spawning fishes, publishing a seminal paper in Science in 2007. A second postdoctoral fellowship with the ARC Centre of Excellence for Coral Reef Studies enabled Glenn to apply these methods to determine the fate of larvae from grouper spawning aggregations in PNG, where he worked closely with remote local communities. He received a prestigious ARC Future Fellowship in 2010, and in the space of only 4 years published 20 papers, focusing predominantly on marine reserve design, connectivity and conservation of tropical fisheries resources. This period of his career was some of his most ambitious in scale, leading to substantial engagement in developing regional management programs in support of local fisheries within PNG and the Solomons.

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METABOLIC AND GROWTH RESPONSES TO ELEVATED PCO2 AND TEMPERATURE FOR TWO SPECIES OF TROPICAL NON-CALCIFYING MACROALGAE (Abstract ID: 28829)

The effects of increasing sea surface temperature and ocean acidification are predicted to influence macroalgal metabolic and growth responses differentially depending on their inorganic carbon source. Algal metabolic rates may increase under elevated temperatures, however, beyond their thermal tolerance, can have negative effects on their physiology. Elevated CO2 is expected to benefit macroalgae, specifically carbon-limited algae. The combined effects are less known and may positively or negatively affect macroalgae, thereby affecting relative algal abundances and potentially shift community composition. The interactive effects of temperature and OA were tested on *Dictyota bartayresiana* (HCO3- -user) and *Amansia rhodantha* (CO2 -user) in Moorea, French Polynesia. Both species were subjected to 400 or 1000 µatm pCO2 conditions at 25, 27, or 30°C in a short-term mesocosm experiment, measuring photosynthesis, respiration, and growth rates of each species. Growth rates of *A. rhodantha* were relatively higher in comparison to *D. bartayresiana* between temperature treatments. Additionally, photosynthesis and respiration rates differed among species within temperature treatments but not pCO2 treatments, specifically *A. rhodantha* having overall higher metabolic rates at 27°C while *D. bartayresiana* had negligible differences across treatments. These results illustrate the importance of examining how multiple stressors may result in varying responses in macroalgae and how they might differ based on their source of inorganic carbon.

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EPIGENETIC MODIFICATION OF AN ANEMONE GENOME THROUGH CYTOSINE METHYLATION REVEALS PLASTICITY IN RESPONSE TO TEMPERATURE STRESS AND SYMBIONT TYPE. (Abstract ID: 28333)

Assessing physiological plasticity of marine invertebrates within the context of global climate change is a growing area of research within the coral reef community. Epigenetic DNA modification through cytosine methylation provides an important mechanism for modifying gene expression patterns in response to environmental cues. Here we utilize a NGS technique to describe changes in methylation patterns within the anemone Exaiptasia pallida under ambient (26oC) and elevated (32oC) temperature conditions and between anemones hosting either B1 or D1 Symbiodinium. Overall, methylation conservation between treatment groups was high, with more than 70% of queried CpG sites showing no significant change in methylation status. The CpG sites that did evidence an average net change in response to both temperature and symbiont type were more prevalent in promoter regions as compared to gene bodies. In response to elevated temperature, 29% of the net change in methylation was attributed to genes associated with Metabolism. For differences between hosts with B1 vs. D1 symbionts, 25% and 22% of net change in methylation was attributed to genes associated with cellular processes and disease (cell recognition), respectively. This work represents a first look at changes in methylation pattern within an anemone in response to both symbiont type and temperature stress. Our results are further discussed within the context of CpG frequency of the underlying genome and the capacity for variability in gene methylation patterns as a potentially important component of physiological plasticity.

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ORIGINS OF HAWAIIAN REEF FAUNA (Abstract ID: 29695)

All living inhabitants of the Hawaiian archipelago necessarily originate elsewhere, due to the volcanic history of the island arc. Two prominent hypotheses regarding the origins of Hawaiian marine species maintain that colonists arrive either from the south (via the Line Islands and Johnston Atoll) or from the west (via Japan). Previous research has shown that Hawaiian endemic limpets (genus Cellana) arrived from Japan 3 - 7 million years ago (Ma; Bird et al. 2011 Mol. Ecol. 20:2128 – 2141). Orange-band surgeonfish colonized from the Central Pacific about 0.5 Ma (Gaither et al. 2015 Mol. Ecol. 24:1543-1557), and butterflyfishes may have colonized from both the West Pacific and South Pacific (Craig et al. 2010; J. Biogeogr. 37:2125 – 2136). Hodge et al. (2014 J. Biogeogr. 41: 2115-2127) resolved two waves of marine colonization into Hawaii at 0 - 3 Ma and 8 – 12 Ma. Finally, Andrews et al. (2014; PLoS One 9: e91665) report evidence for a colonization pathway from the south (Johnston Atoll) to the middle of the archipelago in the protected Papahanaumokuakea Marine National Monument (PMNM). Here, we synthesize available data, and introduce a new data set based on three endemic Hawaiian blennies (Blenniidae) compared to widespread sister species, in order to further elucidate the ages and origins of Hawaiian reef fauna. One emerging conclusion is that a dispersal corridor between Johnston Atoll and the PMNM may constitute an important

entry point for colonization into Hawaii, which provides insight into factors that promote and maintain endemic reef biodiversity.

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UNDERSTANDING THE MAINTENANCE OF SPECIES BOUNDARIES BY EXAMINING HYBRIDISIATION IN CORAL REEF FISHES (Abstract ID: 28592 | Poster ID: 35)

Coral reef fishes comprise the world's most diverse vertebrate communities. Determining how so many coexisting species maintain reproductive isolation is fundamental to understanding the evolution and maintenance of biodiversity on coral reefs. Suture zones, where multiple species-pairs hybridise at biogeographic borders, provide the natural laboratories for studying the maintenance of species boundaries. Comparisons between coexisting species that hybridise and those that do not, provide unique insights into the barriers to reproductive isolation. In this study, we examine the pre-zygotic processes that lead to the breakdown in assortative mating of coral reef fishes. We first use a literature review and field studies to identify locations where hybridisation is common in coral reef fishes. These hybrid hotspots were concentrated at biogeographic borders and represent suture zones: southern Japan; Hawaii-Marshall Islands; Cocos-Christmas-Indonesia; and Socotra-Somalia. At these suture zones we conducted detailed field surveys of abundance, distribution, habitat use, and combined with behavioural observations and dietary analysis. We found that a lack of conspecific partners (low abundance), niche overlap, cohabitation, acceptance and formation of heterospecific social groups, and deliberate mating between species are important promoters of hybridisation. We conclude that mate choice is likely to be the most critical pre-zygotic process and determining how reef fishes choose mates is central to understanding the maintenance of reproductive isolation.

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SEEING THE REEF FOR THE CORALS: A QUANTITATIVE CASE FOR REMOTE SENSING (Abstract ID: 28749)

Coral reefs provide very valuable ecosystem goods and services, but they are severely threatened. An estimated 33-50% of reefs worldwide have already been severely degraded, and the rest are threatened with destruction by mid-century. Despite the severity of the problem, state of the art coral reef assessment remains firmly diver-centric. For a concept study exercise, I downloaded all publicly available data for three well-surveyed coral reef regions: the Great Barrier Reef, Hawaii, and Florida/Puerto Rico/U.S. Virgin Islands. Data were compiled to geolocated values of coral cover, then binned to 1×1 km grid cells to approximate the reef ecosystem scale. Observations were very sparse, both within reefs and across regions. The binned data do not exhibit any trends with large-scale physical parameters (PAR, thermal history, wave history) except for possibly a negative relationship with aragonite saturation state. Coral cover does appear to increase with coral species richness, but also appears to increase with increasing human threats, except overfishing. Overall, the observed patterns contradict the prevailing understanding of how reefs relate to their environment. In truth, because they are so sparse, the available benthic cover data are not actually representative of the ecosystem scale. Thus, the comparison with reef-scale biogeophysical forcing parameters is not sound. Remote sensing is the only feasible means to gather uniform, high-density, ecosystem-scale data across vast coral reef regions.

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REDUCED DISTURBANCE RISKS TO IMPORTANT SOURCE REEFS IMPART SYSTEMIC RESILIENCE TO THE GREAT BARRIER REEF (Abstract ID: 28585)

Coral populations on Australia's Great Barrier Reef (GBR) suffer the combined impacts of stressors such as cyclones, bleaching, and crown-of-thorns starfish (COTS) outbreaks. However, not all of the GBR reefs will have an equal risk of being affected by these disturbances. Marine reserve networks can help the coral recovery by protecting the adult stocks of source populations important for the recolonization of the disturbed reefs. We explored this natural recovery process by identifying the GBR reefs that simultaneously exhibit high potential for replenishment and low risk of disturbances. By combining connectivity and environmental models, we found that a surprising number of the GBR reefs with high replenishment potential also benefited from a reduced risk of disturbances. While the GBR has lost much of its coral cover in recent decades, the presence of reefs with such desirable characteristics will impart a degree of natural systemic resilience to the GBR. Without this inherent resilience, the state of the GBR reefs may have become far worse. With limited options for direct interventions that help coral recovery, management plans should support this intrinsic recovery potential and work in synergy with connectivity processes to sustain the natural resilience of the GBR. We discuss how uncertainty in the recovery processes can be mitigated by prioritising protection of reefs in response to specific disturbances such as cyclone impacts and COTS outbreaks, as well as those reefs that aid the sustainability of the key tourism assets on the GBR.

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RESPONSE OF MELANIN-CONTAINING CELLS IN GUAM PORITID CORALS TO SEDIMENTATION STRESS (Abstract ID: 28066)

A dose response experiment was conducted to evaluate tissue and cellular responses of three species of Porites corals to sedimentation stress. Fragments of P. cylindrica, P. rus, and P. lutea were collected from parent colonies in Apra Harbor, Guam; acclimated to the laboratory; and subjected to varying doses (100 to 400 mg cm-2 day-1) of fine (<1.4 mm) and/or coarse sediments (1 to 20 mm) daily for 4 weeks. Subsets of specimens were sacrificed for histology immediately following collection, acclimation, and 2 and 4 weeks of exposure, respectively. In all three species, abundance of melanin-containing cells (MCC) concurrently decreased in the gastrodermis and increased in the epidermis during acclimation, suggesting cell migration. Following 2 weeks of fine sediment exposure ≥100 mg cm-2 day-1, MCC were absent in both tissues of P. lutea and P. rus. MCC in remaining treatments of P. lutea and P. rus and all treatments of P. cylindrica declined at a slower rate, with absence after 4 weeks of exposure. Accumulations of eosinophilic granules were first observed in P. rus following 2 weeks, and in P. cylindrica and P. lutea following 4 weeks of sediment exposure at ≥100 mg cm-2 day-1. These accumulations were sometimes clumped together and similar in shape and size to MCC. Therefore, accumulations of eosinophilic granules may represent granular amoebocytes capable of forming new MCCs. This study suggests threshold levels for sediment exposure and duration for three species of poritid corals and offers insight regarding MCC as a diagnostic tool to evaluate coral stress.

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THE GEOGRAPHY OF SPECIATION IN CORAL REEF FISHES: THE RELATIVE IMPORTANCE OF BIOGEOGRAPHICAL BARRIERS IN SEPARATING SISTER-SPECIES (Abstract ID: 28186)

Patterns of biodiversity result from evolutionary processes of speciation, range-size transformation and extinction. The influence of geography on these processes has intrigued biologists for centuries. Here we aimed to understand how geography has influenced biodiversity by examining the relative importance of biogeographical barriers in the divergence of extant coral reef fish species. We focused on sister-species identified from a recent phylogeny of four families (Chaetodontidae, Epinephelidae, Labridae and Pomacanthidae). Biogeographical analyses of IUCN range maps revealed species-level vicariance across six major biogeographical barriers: the Amazon and Orinoco rivers, Isthmus of Panama, Hawaiian Archipelago, Indo-Pacific, and a previously understudied barrier termed the Mid-Indian Ocean Barrier. Remarkably, of all six barriers, the Mid-Indian Ocean Barrier showed the strongest vicariant signal. The strength and ongoing influence of the Mid-Indian Ocean Barrier appears to be driven by river outputs and turbidity currents. Interestingly, the majority of sister-species were non-allopatric; their overlap was concentrated in the Central Indo-Pacific, concordant with the hotspot of reef fish diversity. Vicariance and overlap in the Central Indo-Pacific highlight its importance as an area of evolutionary dynamism, where the separation of Indian and Pacific Ocean species, and their subsequent range expansion, has led to increased species overlap and higher regional biodiversity.

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NEW EVIDENCE OF CORAL RECOVERY IN EASTERN PANTHALASSA AFTER THE END-TRIASSIC MASS EXTINCTION (Abstract ID: 29717 | Poster ID: 230)

During the Triassic period corals and reefs reached maximum diversity with the development of extensive carbonate platforms. The end-Triassic breakup of Pangea resulted in rift volcanism leading to prodigious releases of volcanic gases. Ocean acidification and other global perturbations caused reefs to collapse along with the extinction of most corals and marine biotas. After the end-Triassic mass extinction it took almost 25 million years for corals and reefs to recover to their former diversity and biotic structure. Early Jurassic corals are thus rare. Corals of the Hettangian to Sinemurian contain

Triassic holdover species and by the Pliensbachian include many new species. The Toarcian adaptive radiation was a time of major turnover, with evolution of complex coralla and the loss of most Triassic taxa. Corals from the earliest stages of the Jurassic are extremely rare in North America. Here we illustrate previously undescribed corals from Alaska representing the earliest Jurassic appearances in North America. The Hettangian to Sinemurian corals occur as new species of simple, solitary forms belonging exclusively to the family Stylophyllidae. These corals provide new data on Triassic holdover taxa surviving the extinction in island-arc refugia or an earlier Hispanic corridor migration from the Tethys to the Panthalassa Ocean. These Early Jurassic corals allow an opportunity to assess paleoecology, paleobiogeography and biotic recovery during the critical interval following the mass extinction and may offer insight for the recovery phase of the modern reef crisis.
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NEW FRONTIERS: CONSERVATION DRONES IN THE MARINE ENVIRONMENT (Abstract ID: 28999)

Unmanned aerial vehicles (UAVs or drones) represent a new frontier in environmental research and management. Their use has the potential to revolutionise the field if they prove capable of improving data quality or the ease with which data are collected beyond traditional methods. We apply conservation drones to a variety of marine environments, particularly for monitoring purposes, in tropical to polar systems. Our results indicate that the use of this technology can increase monitoring precision, provide access to hard-to-reach sites and be more cost effective than traditional techniques. While careful consideration will be required to ensure coherence of UAV-derived data with historic data-sets, this technology has the potential to improve the speed and quality of evidence based decision making.

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RISK AND RESLIENCE: COP21, CORAL REEFS AND THE NEXT FEW DECADES (Abstract ID: 29345)

Ocean warming and acidification represent the greatest long-term threats to coral reef ecosystems through their influence on the risk and resilience of ecosystem components and processes. Scientific consensus like that of the IPCC (2014) have concluded that coral-dominated ecosystems will be rare or non-existent by mid-century if tropical ocean conditions are not stabilized over the next few decades. Fortunately, the international community has listened to the scientific consensus on this and other threats from climate change, resulting in a commitment by over 190 signatories to the UNFCCC (COP21, December 2015) to hold "global average temperature to well below 2°C above preindustrial levels and (pursue) efforts to limit the temperature increase to 1.5°C" (UNFCC COP21). If fully implemented, Earth is likely to have significant coral reef ecosystems by century's end. While a landmark achievement, very significant questions and challenges remain. Firstly, a better understanding of the changing risk environment as global conditions shift toward stability is required if we are to plan effective adaptation responses. Secondly, the details of how non-climate change factors modify the resilience of ecosystem components and processes requires greater scrutiny and detail. In both these cases, manipulative experiments as well as the widely used modelling approaches need to be expanded. Lastly, it is essential that the coral reef scientific community continue to demonstrate and communicate the relative straightforward yet informative example of coral reefs in a changing climate.
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A MUSHROOM CORAL TRIANGLE BASED ON SPECIES PRESENCE / ABSENCE DATA (Abstract ID: 28690)

Many Indo-West Pacific (IWP) reef coral species show wide-spread ranges with a maximum overlap in the Indo-Australian Archipelago (IAA). This centre of marine biodiversity is popularly known as the Coral Triangle (CT), which is also a focus area for coral reef conservation. The position of its boundary is still under investigation and has changed during the last decade, depending on progressing insight. Research on mushroom corals (Scleractinia: Fungiidae), using presence / absence data obtained from field surveys since 1983, suggests that some areas outside the CT may be richer in species than previously assumed. Within the CT, also variation in species numbers can be observed, which can be attributed to different levels of habitat heterogeneity. Most mushroom coral species show widespread IWP ranges, a few occur in restricted areas, and others show ranges that resemble a supposed centre of mushroom coral diversity. Species of the latter category predominantly occur on deeper reef slopes, which migrated up and downward with fluctuating sea level stands. From an evolutionary point of view, these are not the youngest species, implying that this diversity centre represents a centre of survival rather than a centre of speciation.
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MACROALGAL-HERBIVORE FEEDBACKS AND THE DYNAMICS OF CORAL REEFS (Abstract ID: 29037)

Coral reefs are in global decline with many being overgrown by large fleshy macroalgae. Once established, such regime-shifts are difficult to reverse. Theoretical models have suggested that the stability of these states arises from interactions among elements that form positive feedbacks; reinforcing and maintaining the state. Despite their potential importance there is a current lack of empirical evidence for feedbacks, and hence our understanding of how feedbacks build or erode the resilience of reef systems is limited. Using a combination of natural and experimental macroalgal beds I examined how the structure and composition of macroalgal beds influence patterns of habitat use and foraging of herbivorous coral reef fishes, and the replenishment of herbivorous fish populations. Patterns of habitat use and foraging by herbivorous fishes were influenced by the composition and density of macroalgal stands, with most fishes avoiding areas of dense canopy-forming macroalgae. Comparisons with macroalgal mimics indicate that fishes were responding to the physical structure of the macroalgae. Interestingly, the avoidance these areas extended beyond the boundaries of the macroalgal stands themselves and into adjacent areas that were relatively free of macroalgae. Such edge effects are likely result in a feedback that promotes macroalgal expansion on coral reefs. In contrast to patterns of foraging, there was considerable variation in the settlement preferences of herbivorous fishes, with some species settling almost exclusively to areas of dense canopy-forming macroalgae.

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SELF-RECRUITMENT IN THE RAPIDLY SPREADING INVASIVE LIONFISH *PTEROIS VOLITANS*: IMPLICATIONS FOR POPULATION CONTROL (Abstract ID: 28364)

Since its introduction in the Atlantic, the Pacific Red Lionfish has spread rapidly, colonizing most reefs in the Caribbean in a matter of 5 years. Eradication is impossible; therefore population control has become the focus of management efforts. Population models have been used to estimate the amount of removal required to effectively control lionfish populations and prevent recolonization, however, these models assume completely closed populations in which local adults produce all the recruits to the local population. Understanding the degree of local recruitment is therefore critical to better estimate removal effort for lionfish control. Using genetic parentage analysis we estimate the self-recruitment rate and track local dispersal of lionfish within a reef system in Belize. Self-recruitment estimates ranged from 0.5% to 2.7%; individuals that dispersed within the local reef system moved on average 4 $\pm$ 3 km from their putative parents, recruiting into nursery habitats. We modified an existing lionfish population model to investigate the effect of low self-recruitment rates on population growth and recolonization under various adult removal scenarios (single or monthly removals). The model predicts rapid recovery of lionfish populations after adult removals except when self-recruitment is extremely high. Model results indicate that effective control of lionfish populations will require frequent removals (monthly) at relatively high rates of removal (20 – 45% of the population) if the worst effects of this invasive predator are to be staved off.

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SPATIAL HETEROGENEITY IN RATES OF REASSEMBLY OF CORAL COMMUNITIES FOLLOWING LANDSCAPE-SCALE DISTURBANCES (Abstract ID: 27930)

A variety of perturbations including cyclones, bleaching, and coral predator outbreaks can result in sudden landscape-scale loss of coral and dramatically affect community structure and function. The most commonly used metric to gauge subsequent recovery is the degree to which the reef regains coral cover. However, this metric does not reveal whether the reef community reassembles to its previous composition, or the mechanisms that influence the rate of reassembly. We explored these issues for six sites on the fore reef around Moorea, French Polynesia. Between 2008 and 2010, the reefs were impacted by an outbreak of Crown-of-Thorns Seastars and a cyclone, which together resulted in almost complete loss of coral. Five years later, the rate of re-establishment of

coral cover differed greatly around the island, and contrary to expectation, coral cover is returning most rapidly at sites where the least amount of live coral remained after the disturbances. Although the sites differ in the pace of recovery, all show evidence of reassembly to their pre-disturbance structure in terms of relative abundance of coral genera and of the main functional groups of benthic space holders. The primary driver of spatial variation in rates of recovery was coral recruitment, while subsequent growth and survivorship were of lesser importance in shaping the spatial pattern. Our findings suggest that not all sites are likely to fully recover given the observed heterogeneity in rates of reassembly and the re-occurrence probability of major disturbance events to the fore reef of Moorea.

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CONSIDERING MULTIPLE FACTORS IN ASSESSING THE EFFECTIVENESS OF A LARGE-SCALE MARINE PROTECTED AREA FOR CONSERVING TARGETED FISH COMMUNITIES (Abstract ID: 29216)

The Ningaloo Marine Park is situated on the mid-west coast of Australia and incorporates approximately 300km of tropical/sub-tropical fringing reef system. Originally gazetted in 1987, the park is a popular recreational location that has received steadily increasing visitation over the past two decades. Recreational fishing is one of the most common user activities, with spatial zoning and bag limits being the primary management strategies for the conservation of fish communities. However, despite the relatively large spatial coverage of no-take areas (NTA's; ~34% of the total area) and the length of time in which they have been in place (9-29 years), meta-analysis of surveys conducted over the past 29 years indicates that there has been no change in the effect size of NTA's on highly targeted fish communities through time. While the vast majority of surveys indicate higher target species abundance within NTA's, data collected at high use areas provides evidence for steady declines in the abundance of the primarily targeted fish group (Lethrinidae) both inside and outside of these protected areas. Here we investigate the potential causes of these patterns including the influence of fishing intensity, non-compliance, benthic habitat, reef zone, zoning design and recruitment supply. We scrutinise evidence to support each of these factors and conclude that it is a combination of many of the aforementioned aspects influencing the abundance of target fish groups. Our results highlight the complex nature of drivers of marine populations and the need to consider multiple factors when assessing the efficacy of conservation and marine protected area management strategies.

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EMERGENT CLIMATE CHANGE REFUGIA FROM IMPERFECT CONNECTED REFUGES (Abstract ID: 28747)

As coral reef habitats fragment due to climate change and coastal development, resilient populations and their connectivity become critical for metapopulation persistence. Consequently, there has been an increased scientific focus on coral reef refuges – both natural environments removed from stress, and protected or curated environments such as marine protected areas (MPAs). Although there has been considerable research into the effects of MPAs on local persistence, our understanding of how metapopulation persistence – the ability of an interconnected network of populations to avoid extinction – emerges from the interactions of perturbed, natural refuge and protected environments is still poor. We developed a novel patch occupancy model to evaluate the effects of differential habitat resilience on metapopulation persistence. Habitats were assigned vulnerabilities from a range of beta distributions, which more closely reflects reality. A key finding suggests that refuges need not be invulnerable to perturbation to support metapopulation resilience, so long as habitats remain sufficiently connected. Resilience and connectivity can interact to produce effective refugia from perturbed environments. We thus propose that metapopulation refugia is rarely composed of a few isolated resistant populations, but is instead an emergent property of connected populations with diverse characteristics.

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RE-OPENING HIGH ENERGY WINDOW: CORAL REEF RESPONSE TO SEA-LEVEL RISE AND TROPICAL CYCLONE AT END OF 21ST CENTURY (Abstract ID: 28945 | Poster ID: 402)

Past coral reefs were affected by high wave energy until the late Holocene, where reef growth reached present sea-levels. The present-day coastal areas are generally protected from storm waves because the reef crests serves as a natural breakwater. However, the effect of natural breakwater will decrease if coral cover and its species diversity declines and vertical reef growths stop, because of global and local stresses. Moreover, sea-level rise and intensified tropical cyclones will cause a decrease in the ability of reef to reduce wave energy. In this study, we analyze the effect of natural breakwater on Melekeok reef in Palau at the present and at the end of the 21st century with projected sea-level rise and tropical cyclones. On the present-day reef, wave simulation using the CADMAS-SURF reveals that the reef crest reduces wave height by 96.3 % (incident significant wave height (SWH) is 7 m and significant wave period (SWP) is 12 s). Moreover, this study indicates that the reef crest dissipated 71.1–78.4 % of the incident SWH (8–10 m) under a global sea-level rise and an effect of intensified tropical cyclones at the end of 21st century. Furthermore, the SWH at the coastline is estimated to be 1.2 m (incident SWH is 7 m and SWP is 12 s): the height is 1.5 times higher than that of present day. The above findings imply that the effects of sea-level rise and tropical cyclones will probably cause re-opening of high energy window on the reef. Consequently, it will lead to greater economic and social loss associated with coastal erosion and flooding.

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USING SOCMON TO ADDRESS SOCIO-ECOLOGICAL MANAGEMENT IN THE GULF OF MANNAR (GOM) AND PALKBAY: MARINE ECOSYSTEMS SHARED BY INDIA AND SRILANKA (Abstract ID: 27986)

Coastal communities often rely on goods and services provided by coral reefs and related resources for their livelihood and nutritional needs. At the same time these resources get degraded by over-extraction and harmful extraction techniques. An Ecosystem Approach to resource management can promote sustainable use of marine goods and services for sustaining livelihoods. In this paper we talk about two Marine areas the Gulf of Mannar and Palkbay - where the sea provides for 1,16,747 fisherman families, living in 304 fishing villages along the gulf of Mannar coast in Srilanka and Tamilnadu, India. The paper draws on socioeconomic assessments and monitoring carried out at selected sites in Tamilnadu and Srilanka in 2015. Which in turn provided a holistic understanding of the linkages between the ecological health of the fisheries and associated ecosystems and the people who depend on them. Data has been collected using selected tools from the SocMon SA guidelines. The tools used include a combination of participatory appraisal methods, interviews and surveys of 450 households and 850 individuals to understand the perception of people as well as their ecological and traditional knowledge. It also compares the attitudes of artisanal and trawler fishers towards conservation and management. The paper addresses transboundary usage issues, social resilience and concludes, that to improve compliance both countries, follow the same management plan, species protection and consider co-management or support artisanal fishers to set up LMMA's within their customary fishing areas.
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REVERSING IMPACTS OF DYNAMITE FISHING WITH SOFT CORAL ARTIFICIAL REEFS (Abstract ID: 30147 | Poster ID: 299)

The reef slopes surrounding Pom Pom Island, Malaysia are covered in loose rubble due to extensive dynamite fishing. Stabilizing reef slopes creates available substrate for stony coral colonization, an important step in restoring reef structure and rebuilding a healthy community. Current research covers usage of stony coral artificial reefs for rubble stabilization, but there has been little work on using soft corals for the same purpose as Octocorals are not documented reef builders. We constructed artificial reefs at three sites on Pom Pom in July 2015 using nets with 15x15 cm cells. Each site has two controls and two replicates of each treatment: netting planted with soft coral attached to rubble and netting planted with only rubble. Each quadrat planted with soft coral has approximately 150 experimental soft coral colonies, for a total of 900 replicates. Along the top and bottom of each net and the control quadrats, painted and numbered rubble pieces, called "drop rubble fragments," were placed at 10-cm intervals. Before placement, all drop rubble fragments were weighed, measured, and evaluated for degree of branching. Drop rubble fragment movement was analyzed using ANOVA. In addition

to measuring vertical movement of these fragments over time, we measured soft coral survival and growth using ImageJ. We hypothesized that artificial reefs planted with soft coral attached to rubble would show less rubble movement than artificial reefs planted with only rubble. Furthermore, we predicted that soft coral growth would be inversely correlated with rubble movement over time.

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SYNERGISTIC EFFECTS OF RE-ZONING AND FISHERIES RESTRUCTURE ON CORAL TROUT ABUNDANCE AND CATCH DYNAMICS (Abstract ID: 28509)

Marine no-take reserves, where fishing and other extractive activities are prohibited, are well-known for their conservation benefits, yet their impacts on fisheries remain contentious. Typically, reserves are established alongside other management interventions (including direct changes in the management of local fisheries), making the causal attribution of post-intervention changes to fisheries and fished populations problematic. Typically, such changes are assumed to be due mainly to the implementation of reserves. Here, we explicitly partition the response of catch and population biomass changes of coral trout between reserves and coincident management interventions associated with the 2004 re-zoning of Australia's Great Barrier Reef Marine Park (GBRMP). First, we show that a metapopulation model successfully predicts the response of catch, catch rate, and population biomass to the rezoning and fisheries restructure. Then, we use a sensitivity analysis to show that the reduction in fishing effort that coincided with the rezoning substantially enhanced the conservation benefits of the reserve network, and successfully socialised the fishery cost of the rezoning. Specifically, we show that the approach adopted in the GBRMP produced greater biomass, catch, and catch rate than would have occurred if the rezoning had occurred alone. Our findings indicate that it was the use of effort controls alongside the rezoning that prevented individual fishers from experiencing decreases in catch rate, which are typically associated with reserve establishment.

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EXPLORING TRADE-OFFS, LIKELIHOOD OF IMPLEMENTATION AND EQUITABILITY IN TRANSBOUNDARY MARINE RESERVE NETWORKS IN THE PHILIPPINES (Abstract ID: 28293)

Scholars and development groups have created guidelines for optimal designs of marine reserve networks that could achieve multiple objectives. However, as in the case of individual marine reserves, effectively implementing and enforcing these network designs depend on social, economic and political factors. There is increasing recognition that the spatial fit of governance, ecosystems, and ecological processes is also a key factor to consider when designing and implementing reserve networks. Configurations of marine reserves within a network will vary depending on the spatial extent of governance units. Hence, institutional arrangements that can accommodate transboundary arrangements for reserves will be required for reserve networks that span multiple governance units. These arrangements will also require mechanisms that can reallocate costs and benefits of implementing marine reserve network designs equitably across governance units. In the Philippines, alliances of local governments are advocated to scale up to form marine reserve networks. These alliances usually have 2-3 local government members, some including all coastal local governments within provinces. We explore how varying governance arrangements affect network design configurations for different objectives, and discuss the trade-offs between achievement of objectives and likelihood of their functionality for each scale. Some mechanisms are proposed that could ensure that the costs and benefits of networks are equitably distributed across governance units.

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MACROSCOPIC AND MOLECULAR ASPECTS OF REGENERATION IN THE CARIBBEAN STAR CORAL, MONTASTRAEA CAVERNOSA (Abstract ID: 28787 | Poster ID: 34)

Absolute coral cover in the Caribbean has decreased more than 70% since the 1970s. Given this extreme decline it is critical to determine the factors that most strongly affect coral regeneration in this region as well as the molecules that are active during the regenerative process. Transects in marine regions of interest in the coastal waters of Grenada and Carriacou were photographed weekly during fall 2014. Images were captured every 0.5 m along 0.5 m x 30 m long belt transects near targeted coral heads both inside and outside marine protected areas. Twelve mm diameter x 2 mm deep circular lesions were made on 124 healthy M. cavernosa colonies at 10-12 m depths. Water samples were collected weekly for organic nutrient component analysis. Analysis of benthic diversity as a proxy for ecosystem heath, organic nutrient levels, and the presence of a marine protected area were examined for their potential impact on M. cavernosa tissue regeneration rates. Using these predictors, separate mathematical models for gross tissue regeneration were developed for Grenada and Carriacou. During fall 2015, identical circular lesions were made on 30 healthy M. cavernosa colonies at 10-12 m depths at sites in Carriacou selected from the previous year. Lesions were re-sampled bi-weekly during the regeneration process to collect tissues for proteomic analysis. Differential expression of proteins associated with regeneration was assessed in regenerating and non-regenerating tissues using mass spectrometry.

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A NEW CLASSIFICATION SYSTEM FOR MARINE PROTECTED AREAS (Abstract ID: 30150)

Marine protected areas (MPAs) are now a global conservation and management tool. MPAs are used to enhance the resilience of linked social-ecological systems with the aim of conserving biodiversity and providing ecosystem services for sustainable use. However, MPAs implemented worldwide include a large variety of zoning and management schemes from single to multiple-zoning and from no-take to multiple-use areas. The current IUCN categorization of MPAs is based on management objectives which many times have a significant mismatch to regulations creating a strong uncertainty when evaluating global MPAs effectiveness. Here we present a novel global classification system for MPAs based on regulations of uses aimed at replacing IUCN categories. We built scores for uses weighted by their impact on biodiversity. Each zone within a MPA was scored and a MPA index integrates the zone scores taking into account their size. Our approach thus classifies MPAs as well as each MPA zone individually. We show that this system unambiguously discriminates the impact of uses whereas IUCN categories do not. Clearly distinguishing between different levels of uses is central to inform MPAs establishment and conservation targets. We anticipate this novel classification system to be rapidly and widely applied by managers, spatial planners, policy-makers and scientists, when designing new MPAs, assessing existing ones and comparing outcomes at a global scale.

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FISHING PRESSURE, DESTABILIZATION OF CORAL-REEF FOOD WEBS, AND ECOSYSTEM-BASED MANAGEMENT (Abstract ID: 28035)

Managing fisheries for ecosystem resilience is essential, but practical guidance is limited by food-web complexity. Key processes and mechanisms behind ecosystem overfishing in coral-reef systems were revealed by combining novel food web models with extensive field datasets. The food webs were constructed by grouping species functionally, and not taxonomically, based upon the way they capture, process, and transfer energy. We find that fishing pressure enhanced the strength of direct interactions within food webs, including density dependence, competition, and predation, and stripped away the benefits of indirect, asynchronous interactions that harmonized the structure and function of food webs. Fished systems became more synchronized and productive when approaching maximum sustainable yield (MSY), but larger fluctuations diminished catch stability, and subsidized competitively-superior algal pools that threaten coral-reef habitats. Three fisheries management scenarios were contrasted with respect to economic objectives and ecosystem states. The results agreed with conservative multispecies biomass-based targets from the Caribbean and Indian Oceans, but offered dynamic guidance that was specific to individual guilds. We find that many well-established fisheries policies have foundational flaws when applied to coral reefs, and offer practical guidance to help ecosystem-based management evolve.

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SPATIAL DISTRIBUTION AND SURVIVAL OF *AMPHIPRION BICINCTUS*AND THE CONSEQUENCES OF THE DECLINE OF THEIR HOST ANEMONES IN THE GULF OF AQABA, ISRAEL (Abstract ID: 28175)

Anemonefishes' obligatory mutualism with sea anemones dictates their occurrence on coral reefs. We examined whether the spatial location, number and size of the host sea anemones *Heteractis crispa* and *Entacmaea quadricolor* affected the settlement, habitat usage, and survival of the two-band anemonefish, *Amphiprion bicinctus*. In a 300 X 30 m study site off the coast of Israel in the Gulf of Aqaba, we followed the fish and anemone populations for 13 consecutive censuses from October 1996 to August 1997. Settling anemonefish tended to cluster together but displayed significantly dispersed distributions in relation to adult fish and breeding pairs. Adult and juvenile anemonefish associated more with, and exhibited higher survival in, *E. quadricolor*. Settlers most often associated with *H. crispa* with no difference in survival rates between the anemone species. In follow-up censuses from 1997 to 2015, sea anemone and anemonefish numbers declined by over 80%, from 87 *E. quadricolor* and 112 *H. crispa* to 15 and 12, respectively. In 2015, every anemone was occupied, with most *E. quadricolor* inhabited by adults. The anemones left at the study site, on average, hosted more fish per anemone than in the original population. This saturated habitat would potentially hinder anemonefish recruits from settling. These results indicate that if the host anemone population does not recover and provide habitat for settling anemonefish and the anemonefish community, the anemonefish could face local extinction.

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THERMAL ADAPTATION AND SELECTIVE BREEDING IN CORALS FROM THE WORLD'S HOTTEST REEFS (Abstract ID: 29311)

Corals in the Persian Gulf (PG) have already experienced warming on par with end-of-century projections for most reefs. We characterized traits that enable PG corals to withstand summers of up to 36°C and evaluated their suitability for heat tolerance selective breeding. Firstly, thermal responses in Platygyra daedalea from the PG were compared with conspecifics from the milder Indian Ocean (IO). At 33 and 36°C, PG corals had ~50% higher survival rates in both symbiotic adults and their non-symbiotic larvae. PG hosts had greater antioxidant capacity and their Symbiodinium had better retention of photosynthetic performance. Superior heat tolerance of PG versus IO corals was maintained after acclimation to a common environment and was underpinned by genetic divergence in host and Symbiodinium. These results show that adaptation of both partners enables PG corals to cope with extreme temperatures. Secondly, we cross-bred P. daedalea from the PG and IO and compared heat tolerance of hybrid versus purebred larvae from each region. Fifty families were bred under controlled conditions and the survival of >10,000 non-symbiotic larvae was tracked at ambient and elevated temperatures. The genetic contribution of PG sperm to IO eggs produced hybrids that, on average, had 37% higher survival at 36°C than purebred IO families. This hybrid gain in heat tolerance matched that of purebred PG crosses, thus demonstrating the success of selective breeding. Finally, we genotyped breeding parents and their offspring to reveal important markers and alleles associated with heat tolerance.

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ORIGINS AND DIVERSIFICATION PATTERNS OF SCLERACTINIAN CORAL DIVERSITY (Abstract ID: 28136)

Recent accumulation of molecular data and development of phylogenetic models have provided means to test various evolutionary patterns. In particular for scleractinian corals, the resolution of difficult taxonomic issues aided by robust phylogenetic data has opened up opportunities to investigate the origins of global and regional diversity. Here we compare diversification rates between reef and non-reef corals, and test the evolution of the Coral Triangle center of diversity. First, using time-calibrated evolutionary trees of living coral species in conjunction with a dynamic model of speciation, extinction and trait transitions, we show that reef corals have undergone more rapid diversification than non-reef species, supporting the onshore-offshore diversification trend inferred previously for corals and several other marine taxa. However, the most recent common ancestor of all extant scleractinians is most likely an azooxanthellate species, and transitions from non-reef to reef taxa are not insignificant, highlighting the importance of both ecological groups in the evolution of coral diversity. Second, we use a phylogenetic model of biogeographic evolution to show that origination rates within the Coral Triangle are lower than in surrounding regions, refuting the long-standing center of origin hypothesis. Instead, the high diversity of reef corals in the Coral Triangle is due mainly to range expansions into this region of species that evolved elsewhere, strongly supporting the notion that range shifts play a major role in generating species diversity gradients.

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STATUS OF CORAL REEFS IN XISHA ISLANDS(PARACEL ISLANDS) (Abstract ID: 28412)

Xisha Islands is mostly the atoll reefs, located about 300 kilometers southeast of Mainland China's Hainan Island, and between the latitude 15 ° 45'N~17 ° 15'N, longitude 111 ° E ~ 113 ° E. It consists of about 44 islands, and most of these islands are belonging to 8 large atolls. The biodiversity in Xisha Islands is quite abundant. Some 210 species of the reef corals were recorded so far. Overfishing and destructive fishing practices have badly damaged coral communities in Xisha Islands, the valuable edible fish and mollusc species are the target, causing most high-value fish species to become locally extinct. In terms of live percent cover of reef corals, coral reefs of the Xisha Islands was in good condition before 2002, when coral cover was >70%. The live cover of reef corals in Yongxing Island (Woody Island), Xisha Islands were 68% , 51% and <1% in 2002, 2006 and 2009 respectively. Comparing to the historical record of the corals in these area, coral reefs are degrading over the last 20 years in a fast pace. The recent survey founds much variation of restoration processes existed between reefs of the Xisha Islands. The reason for this may be due to the recruitment limiting, which is involving hydrodynamics.

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SUSTAINABILITY PERFORMANCE ASSESSMENT FOCUSING ON CORAL REEF PROTECTION BY THE TOURISM INDUSTRY IN THE CORAL TRIANGLE REGION (Abstract ID: 28086 | Poster ID: 595)

Tourism is a major industry in the Coral Triangle region, responsible for economic benefits, but also for negative social and environmental impacts. Considering that in this area, tourism is directly dependent upon healthy coral reef ecosystems, and that the vast majority of the reefs are threatened by local human activities, an approach to evaluate this industry's sustainability performance would be particularly valuable. In this study, we selected 10 key indicators, out of 681, that were directly relevant to the impacts of tourist activities on coral reefs in economic, social, environmental, and wildlife aspects of sustainability. Optimization methods were used to develop efficiency, inefficiency and overall models, in three scenarios, to measure sustainability performance focusing on coral reef protection (SPFCRP) by the tourism industry for all six countries in the Coral Triangle region, from 2008 to 2012. Our results showed that Indonesia (IND) had the best relative SPFCRP among countries in the region, followed in descending order by; Papua New Guinea, Malaysia, Philippines, Timor-Leste (TIL), and Solomon Islands (SOI). IND can be considered as an example in most key indicators for other countries in the Coral Triangle. Conversely, SOI and TIL are the ones with the greatest need for improvement. Future plans to achieve higher SPFCRP by the tourism industry in each country can be made if a comprehensive sensitivity analysis is carried out, provided that more data on each key indicator is available.

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THE CARBONATE BUDGET OF ST. CROIX REEFS 35 YEARS LATER (Abstract ID: 29407)

In the early 80s, a carbonate budget was determined on NW St. Croix (USVI). On 2 shore-normal profiles, carbonate production (Pg) was determined along >50 chain transects from shore to a depth of 43m. Bioerosion (BioE) was locally determined; sediment export was measured during a spectrum of conditions. Seven cores documented reef structure and accretionary history. Based on these measurements, BioE was ca. half of Pg, and nearly 50% of the sediment was exported, mostly during storms. A recent study repeated these measurements – 3 decades later. Pg was based on similar chain transects and local coral-growth rates. Fish and urchin data provided estimates of BioE due to grazing. These were combined with infaunal losses to compute total BioE. Over the past 3 decades, coral cover declined by ~31% relative to 1980; Pg and BioE have been reduced by ~21%. Lower Pg approximates only part of the lost accretionary potential over 30 yr. Increased storminess will accelerate sediment export. Even small storms (~5/yr) increase fair-weather export by an order of magnitude; transport during Hurricane Hugo was 5 orders of magnitude greater. Considering coral decline across the world ocean, these results suggest that the accretionary potential of coral reefs is declining rapidly. While the absolute rates are insufficient to drown reefs and reef islands

by 2100, the impacts on reef structure, sediment supply and protection from storm waves are profound. Quantifying the balance between reef building and sea-level rise will require studies that consider more than coral cover. Further, sediment export is likely to have a greater impact than either changing Pg or BioE.

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THE ROLE OF INVERTEBRATES IN CORAL REEF MICROBIALIZATION (Abstract ID: 28907 | Poster ID: 298)

Microbialization is the process by which microbes replace macro organisms on a coral reef and metabolize the majority of the bioavailable energy. The microbialization score is a practical metric for evaluating and comparing reef health, as there is a direct relationship between the increase in microbial metabolism and the cumulative human impact on the ecosystem. As of now the microbialization score only accounts for the biomass of fish and microbes in coral reefs, neglecting other organisms. Invertebrates are especially known to significantly contribute to trophic dynamics in coral reefs. To further the accuracy of this metric we measured body dimensions of Gastropods and Crustaceans, and applied biometric regressions that convert the length and width of the respective organism to its wet weight. These measurements were then applied to the Metabolic Theory of Ecology, an equation that predicts the organisms metabolic rate based on its body size and temperature. The average abundance of Gastropods and Crustaceans was then assessed by analyzing benthic time lapse images and used to calculate the invertebrate metabolic rate on the reef. The so generated invertebrate metabolic rate was then added to the already existing microbialization score calculations. This addition of reef invertebrates will enable further accuracy of the microbialization score, and allow for a more comprehensive assessment of the status of a coral reef.

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TEACHING STYLES IMPACTS STUDENT ACHIEVEMENT IN A RESEARCH-BASED UNDERGRADUATE SCIENCE COURSE (Abstract ID: 28370 | Poster ID: 705)

Inquiry-based instruction in undergraduate science courses connects students to research and prepares them for careers in science, technology, engineering, and mathematics (STEM). Often, graduate Teaching Assistants (TA) with differing experience and teaching methods are responsible for leading hands-on laboratories. This study determined how differences in TA teaching methods and styles impact student achievement in an ecology research course at the University of Hawai'i, Mānoa. In this course, TAs write their own weekly quizzes and teach material according to their personal teaching style. We observed TA teaching style by measuring the number of open and closed questioning, pacing, use of digital media, question wait time, and other indicators that are shown to affect student learning. We measured differences in student responses on concept surveys and analyzed quizzes with Bloom's Taxonomy. Several characteristics of teaching style, including frequency and type of questioning, had positive associations with student scores and survey responses. Students received the lowest quiz scores and had no improvement in homework scores when asked to define or recall concepts on quizzes while students received higher quiz and homework scores when asked to analyze and synthesize concepts. These results indicate that TA teaching methods may have a stronger impact on student achievement than previously known. This research suggests universities should provide training for TAs to develop teaching methods that promote student achievement and encourage students to pursue careers in STEM.

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PALEOTEMPERATURE RECORDS FROM CUBAN CORALS (Abstract ID: 30141)

Understanding the long-term patterns of climate variability in the Caribbean region is critical to predicting such changes in the future. Coupled ocean-atmosphere systems including the North Atlantic Oscillation (NAO) can vary on multi-decadal time scales, remaining in sustained positive or negative phase for decades. Previous paleoclimate records from corals in Bermuda and the Red Sea show that multi-decadal NAO variance increased over the past century compared to the preceding 150 years, suggesting high variability will continue in the near future. However, there are also striking differences during the earliest part of the records, potentially due to past changes in NAO stationarity. Additional coral paleoclimate records are needed from the Caribbean region in order to constrain the spatial patterns of past NAO variability. Coral paleoceanographic reconstructions in the Atlantic basin are still relatively uncommon compared to the Pacific, and different coral species must be investigated to determine if geochemical proxies reliably record climate. Here we report on new results from a 227-year drill core obtained from a Siderastrea siderea coral in the Jardines de la Reina off southern Cuba. Coral Sr/Ca data over the past 35 years show a very clear seasonal cycle and strong correlation to monthly sea surface temperature (SST) from satellite observations. The Sr/Ca-SST relationship is also strong over interannual time scales such as winter-season averages, indicating the great potential for constructing paleoclimate records from corals throughout Cuba.

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A BRAVE NEW WORLD FOR CARIBBEAN REEFS (Abstract ID: 27913)

Coral reefs face an uncertain future as they continue to respond to pervasive human pressures, particularly overfishing, pollution and climate change. At a time of global crisis, the need to understand how and why reefs are changing has never been greater. Here we document profound long-term shifts in the species composition of Caribbean corals over the past five decades. At a seascape scale spanning 100s of kilometers, no coral species today is as abundant as it was in the 1970s, and consequently all ecological functions performed by them have diminished. Species abundances are lowest today where herbivores are rare, and macroalgae have largely replaced corals. In contrast, where herbivores are more abundant, novel coral assemblages are reassembling on a new trajectory, despite elevated mortality from disease and climate change. Restoration of herbivory to foster recruitment and survival of corals is key to rebuilding ecosystem structure and function of Caribbean reefs in the face of further global change.

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THE 2016 CORAL BLEACHING EVENT IN AUSTRALIA (Abstract ID: 30169)

Summer temperatures in February-April 2016 have caused severe and widespread coral bleaching in Australia. On the east coast, this is the third mass bleaching event for the Great Barrier Reef (GBR) and 93% of reefs have been affected. In the remote northern 1000km sector of the GBR, >80% of reefs have been severely bleached with heavy losses of corals, and only 1% are untouched. Compared to earlier mass bleaching in 1998 and 2002, 2016 is much more severe, with 50-80% coral mortality recorded on northern reefs. The geographic footprint of each of the three events has been different, with each one explained by where the hottest temperatures occurred. Based on aerial and underwater surveys of >1000 reefs in 2016 and 650 reefs in 1998 and 2002, we can now identify reefs that have bleached 0, 1, 2 or 3 times, and examine their attributes. Over time progressively fewer GBR reefs have escaped bleaching, and because of the severity of the most recent event, hundreds of reefs have bleached for the first time in 2016. For the Great Barrier Reef and elsewhere, we have already entered an era when the return time of mass bleaching caused by global warming is shorter than the recovery time of long-lived coral assemblages.

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CORAL TRIANGLE INITIATIVE ON CORAL REEFS, FISHERIES, AND FOOD SECURITY MARITIME LOCAL GOVERNMENT NETWORK: TO IMPROVE COASTAL AND MARINE RESOURCE GOVERNANCE (Abstract ID: 28133)

There are more than 1000 of local governments across CTI region. Maritime Mayor position plays important roles as a Political, Government, and Community Leader. There are estimated 120 million people living in coastal communities who are directly dependent on the Coral Triangle's resources for their food and livelihoods and are considered the most direct beneficiaries of Coral Triangle Initiatives on Coral reefs, Fisheries and Food security (CTI-CFF)'s coastal and marine resource management programs. Many constituencies that can be targeted at the local level and development partners and international NGOs have directly engaged and worked with coastal communities across the Coral Triangle through their various community-based programs. The CTI-CFF Regional Secretariat, NCCs and Partners are working to expand the participation of local government leaders in CTI-CFF activities, including through a CTI Local Government Network (LGN). The network aims to improve the capacity of local government leaders in addressing various coastal and marine resource sustainability issues in their localities and to recognize their critical role in achieving the goals of the CTI-CFF. The CTI-CFF Maritime LGN was launched in May 2011 by a group of enthusiastic mayors and local leaders from across the CT Countries to promote cooperation between local governments, how the local government and/ or community is managing coastal and marine areas; how coastal law environment is facilitated and implemented; and how the role of tourism is promoting better management of marine and coastal areas.

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CHINESE CORAL REEF MANAGEMENT AND RESEARCH: ENHANCING THE SCIENTIFIC FOUNDATION FOR BEST PRACTICE, ADAPTIVE MANAGEMENT IN THE SOUTH CHINA SEA (Abstract ID: 29947)

Chinese coral reef research and scientific knowledge has increased greatly over the last two decades, but the condition of Chinese coral reefs has declined markedly over the same period- as it has in many areas globally. In particular, there has not been sufficient integration between scientific knowledge and management agencies in assessing and responding to changes in condition and management effectiveness. We are adapting best practices in science-based adaptive management to the Chinese context, to assess the condition, pressures, management approaches and resilience of coral reefs in the Sanya area of south China, in turn to provide recommendations for future management planning. Importantly for the effectiveness of these measures, we are simultaneously adapting processes for engagement between scientific agencies and management agencies, to develop effective practices and approaches for building and sustaining partnerships and capacity in coral reef management in southern China.

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HIGH IN SITU SETTLEMENT RATES AND EARLY SURVIVORSHIP OF HARD CORALS IN A CARIBBEAN REEF (Abstract ID: 29322 | Poster ID: 170)

Coral settlement and early survivorship are key ecological processes in reef resilience. In this study, we investigated the temporal and spatial variation of coral settlement and post-settlement survivorship in different reefs with high and low coral cover in Los Roques Archipelago, Venezuela. In situ estimations of settlement and post-settlement survivorship were compared between months of expected gamete release for broadcasters, and months when larval supply was expected mainly from brooders. Terracotta tiles were deployed at reefs with high (>50%) or low (<15%) hard coral cover, and recruit survivorship was evaluated during their first 4 months of age by monthly examination of the tiles. Overall, mean (± SD) settlement rates varied between 30 ± 46 and 236 ± 143 individuals $m^{-2}$ $month^{-1}$. At particular reefs and times, settlement rates were up to 7 times higher than previously reported for the Caribbean region. Settlement rates varied between reefs, but were similar between seasons, suggesting that settlement does not increase significantly after a spawning event. Survivorship of settled corals up to 4 months old varied from 22 to 49% between reefs and was higher at reefs with more coral cover. Our results support the theory that preserving reefs with high coral cover (and maintaining the biological and environmental factors that promote this condition) will result in enhanced settlement and survival of coral in its early life-stages, and therefore is a key factor in the conservation of coral reefs.

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CUMULATIVE EFFECTS OF SEDIMENTS, ORGANIC NUTRIENT ENRICHMENT AND HIGH TEMPERATURES COMPROMISE THE EARLY LIFE HISTORY STAGES OF THE CORAL ACROPORA TENUIS (Abstract ID: 28460)

Elevated suspended sediment concentrations, nutrient enrichment, and rising seawater temperatures are each known to have detrimental effects on the early life history stages of hard corals. However, studies of the combined effects of these stressors on these vulnerable early life history stages are lacking. We conducted a series of experiments to test the interactive impacts of suspended sediments (up to five levels), organic nutrient enrichment (three levels), and temperature (up to five levels) on gamete fertilization, embryo development, larval settlement and juvenile survival for the common inshore coral *Acropora tenuis*. Fertilization and settlement were significantly reduced by increased levels of suspended sediments and temperature, while abnormal embryo development increased when elevated temperature and nutrients co-occurred. Juvenile survivorship was reduced by suspended sediments and high temperatures together with nutrients. The observed rates of change, and type of interaction (additive vs synergistic effects) depended on the stressor combinations, and also varied between life stages. Overall, gamete and embryo stages were more affected by poor water quality and temperature stress than juveniles. These results demonstrate that the cumulative exposure to suspended sediments, nutrient enrichment and elevated temperatures over all early life history stages is likely to result in a critical failure of larval supply and recruitment for this species.

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CORAL SUCCESSIONS IN THE GREAT BARRIER REEF DURING GLACIAL-INTERGLACIAL CYCLES (Abstract ID: 28444)

Tropical coral reef ecosystems have been affected by drastic sea level and environmental changes during Quaternary glacial-interglacial cycles. However, their responses to these perturbations prior to the Holocene are still poorly understood. Recent offshore drilling of the submerged fossil reefs along the shelf edge of the Great Barrier Reef of Australia (GBR) revealed multiple reef sequences formed during the last glacial period and subsequent deglaciation (IODP Expedition 325). A total of 34 boreholes drilled along four transects at three localities (Hydrographers Passage, Noggin Pass, and Ribbon Reef) were used to resolve for the first time the geometry and composition of the GBR during glacial-deglacial conditions when the continental shelf was exposed and reef growth was restricted to the shelf edge. Here we analyse the evolution of reef coral composition in the GBR during glacial-interglacial cycles by comparing the IODP Exp. 325 data set with coral data from two deep boreholes drilled in 1995 in Ribbon Reef 5 (RR5) and Boulder Reef (BR) in the northern GBR (International Consortium for GBR drilling). The RR5 and BR boreholes record a succession of highstand reef sequences formed during late deglacial-interglacial conditions when the shelf was innundated. Our statistical analysis points to a marked difference in coral composition between glacial-early deglacial fringing reefs and late deglacial-interglacial barrier reefs, and highlights the relationships between reef architecture, shelf morphology and coral composition.

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ANCESTRAL GENETIC DIVERSITY ASSOCIATED WITH THE RAPID SPREAD OF STRESS-TOLERANT CORAL SYMBIONTS IN RESPONSE TO HOLOCENE CLIMATE CHANGE (Abstract ID: 28361)

Coral communities in the Persian/Arabian Gulf (PAG) withstand unusually high salinity levels and regular summer temperature maxima of up to ~35 °C that kill conspecifics elsewhere. Due to the recent formation of the PAG and its subsequent shift to a hot climate, these corals have had only <6,000 y to adapt to these extreme conditions and can therefore inform on how coral reefs may respond to global warming. One key to coral survival in the world's warmest reefs are symbioses with a newly discovered alga, *Symbiodinium thermophilum*. Currently, it is unknown whether this symbiont originated elsewhere or emerged from unexpectedly fast evolution catalyzed by the extreme environment. Analyzing genetic diversity of symbiotic algae across >5,000 km of the PAG, the Gulf of Oman, and the Red Sea coastline, we show that *S. thermophilum* is a member of a highly diverse, ancient group of symbionts cryptically distributed outside the PAG. We argue that the adjustment to temperature extremes by PAG corals was facilitated by the positive selection of preadapted symbionts. Our findings suggest that maintaining the largest possible pool of potentially stress-tolerant genotypes by protecting existing biodiversity is crucial to promote rapid adaptation to present-day climate change, not only for coral reefs, but for ecosystems in general.
http://www.pnas.org/content/113/16/4416.full

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FISHERIES MANAGEMENT MEDIATES ALGAL CONSUMPTION THRESHOLDS ON CORAL REEFS IN KENYA (Abstract ID: 28631)

Herbivory is a key process that mediates the abundance and production of primary producers in both terrestrial and aquatic ecosystems. On tropical coral reefs, the ability to avoid phase shifts from coral to seaweed dominance relies primarily on the balance between grazing intensity and algal production, but also by other losses of algae through physical disturbances and sloughing. In this study, we examine thresholds of herbivory needed to prevent algal accumulation using experimental substrata and underwater video cameras on Kenyan reefs under different fisheries management regimes. Average production rate of algae across six study sites was 2.1 g algae m-2 day-1. Herbivory at older fisheries closures and heavily fished reefs was high enough to prevent algal accumulation, although attributable to different taxa (i.e. sea urchins or fishes). Non-juvenile parrotfishes (> 20 cm) had a particularly important role at fisheries closures.

Consequently, reefs protected from fishing that lack sea urchins and larger-bodied scraping parrotfishes are likely to have grazing intensities below the threshold required to prevent phase shifts, which is approximately 70% of algal production. Where fishing is allowed, we estimate 303.97 g m-2 of sea urchins is needed to prevent algal accumulation, and where fishing is prohibited, 12.28 and 59.04 g m-2 of scraper and grazer biomass is needed, respectively. These empirical results provide a mechanistic basis to estimate thresholds of grazing necessary for preventing algal accumulation and phase shifts on coral reefs.

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DEPTH IS A MORE POTENT STRUCTURING FORCE FOR BRACHYURAN CRAB ASSEMBLAGES THAN LATITUDE, GEOGRAPHY, OR HUMAN IMPACT ACROSS THE HAWAIIAN ARCHIPELAGO (Abstract ID: 29599)

Shallow coral reefs are extensively studied, and although scleractinian corals have been recorded to 165 m, little is known about other mesophotic coral reef ecosystem (MCE) inhabitants. Brachyuran crabs fill many ecological and trophic niches on reefs, making them ideal candidates for evaluating species composition among depths. Here we ask if MCEs host the same communities as the shallower reefs spread across the entire 2400 km Hawaiian Archipelago. We deployed Autonomous Reef Monitoring Structures (ARMS) for two years among shallow sites (12 m) across the latitudinal gradient of the Hawaiian Archipelago to compare directly with a depth gradient (12, 30, 60, and 90 m) south of O'ahu island. Over 650 brachyuran crabs representing 130 morphospecies (21 families) were found. Community composition was not significantly different among shallow sites spread across the archipelago, but was significantly different and highly stratified across the depth gradient. We show that 90 m of depth is a more potent determinant of brachyuran community composition than the latitudinal, geographic (high vs low islands), or anthropogenic impact (human population size) gradient across the archipelago. Deeper reefs host significantly different brachyuran communities than shallow ones in Hawai'i, and only 3 of 130 morphospecies (~4%) occurring across the entire depth range (mesophotic to shallow) sampled. Further research on the cryptic reef-dwelling fauna is needed for identifying areas of unique biodiversity, as well as boundaries between depth- stratified reef ecosystems.

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IMPLEMENTATION OF EAFM IN INDONESIA, WILL SUSTAIN THE FISHERY? (Abstract ID: 29197 | Poster ID: 257)

Different perception on ecosystem approach to fisheries management (EAFM) drives misleading of EAFM implementation in Indonesia. EAFM perception using existing paradigm (single sector specific) may not consider the impact of fishing to ecosystem. The paper reviews the central paradigm and proposes the extension of the conventional management to achieve better ecosystem consideration. We also discuss the misusing of EAFM as tools to reduce poverty in fishery which may increase fishing pressure leading to unsustainability. As Indonesian fisheries are dominated by small-scale fisheries (SSF) and about 25 % are reef fisheries, promotes conservation should be carefully integrated to SSF. We conclude with comments on the sustainable development: the balance of ecological well-being and human well-being.

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PUT FISHERS' KNOWLEDGE IN THE RECONSTRUCTION OF LONG-TERM REEF FISH CATCH DATA (Abstract ID: 28148)

Reef fisheries in Indonesia play an important role, both culturally and as a reliable source of food security, but remain under-reported in the statistics. Reconstructing catch data based on limited data requires lots of works. Fishers'ecogical Knowledge (FEK) is an important source of information about continuity and change in coastal ecosystems. Fishers' continued experience with coastal environments may provide important evidences and facts which unfortunately being ignored in the coastal science and management. Detailed knowledge of resources, environment and fishing practices were collected from coastal fishers by conducting semi structured interview to explore its potential for constructing trends within fisheries. We, therefore, come with a 3 steps model of reconstruction. First, available limited fisheries data statistics were plotted to obtain a basic model of fisher's growth. Second, time-lined from fishers' knowledge was placed to adjust the model of fishers growth. Reconstruction of fishers time-series data was the result of this step. In the third step, fishers time-series data was employed to produce gear and catch time-series data through extrapolation and interpolation data from fishers. The final result of long-term catch data showed a sudden increased of catch in the year of 2007 and followed by gradual reduction of higher trophic group of reef species such as groupers, emperors and snappers. Historical time series data is important for fisheries sustainability and overcasting fisheries management.

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CONNECTIVITY OF THE SKUNK CLOWN FISH IN THE INDIAN OCEAN USING A COMBINATION OF MICROSATELLITE AND MITOCHONDRIAL GENETIC MARKERS (Abstract ID: 27864)

Knowledge of connectivity, the exchange of individuals between populations on coral reefs, is vital for a correct spacing of Marine Protected Areas. Dispersal between reefs is limited to a weeks to months-long pelagic larval stage. This study uses the Skunk Clown Fish (Amphiprion akallopisos) as a model species to assess connectivity. It has a disjunct distribution, occurring in the Western Indian Ocean (WIO) and the Eastern Indian Ocean (EIO), separated by more than 4.500 km of open sea. We use a combination of mitochondrial (MtDNA, Control Region) and 15 highly polymorphic microsatellite loci. Fin tissue of 394 individuals from 22 different sites in the WIO (Kenya, Tanzania, Madagascar, and Mozambique) and the EIO (Indonesia) was analysed. Mitochondrial and nuclear markers concurred in detecting strong population structure between the EIO and the WIO populations (AMOVA: $\Phi$ct = 0.63; Fct= 0.10 respectively, P<0.001 both), and panmixia within the EIO. Within the WIO, however, MtDNA did not reveal population structure ($\Phi$st = 0.006; n.s.), whereas microsatellite data indicated genetic differentiation between Northern Kenyan populations and the rest, and, to a lesser extent, between Madagascar and African mainland populations, identifying two zones of restricted gene flow that may be either recent or incomplete barriers to larval dispersal. The Skunk Clown Fish probably originated in the EIO from where it was able to colonize the whole Indian Ocean through stepwise dispersal but later disappeared at stepping stone locations in the Central Indian Ocean due to competition.

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MILLENNIAL-SCALE ECOLOGICAL CHANGE IN CARIBBEAN SPONGE COMMUNITIES (Abstract ID: 28921)

The siliceous spicules of sponges preserve exceptionally well in reef sediments after sponges die. Cores of approximately 3 m were extracted from three reefs in Bocas del Toro to explore changes in spicules assemblages over the last 1–3 thousand years. Spicules were extracted every 5 cm along the cores and identified to morphotype using an in-house reference collection. Of the 12 morphotypes observed monoaxial and ellipsoidal spicules dominated. We observe that moving up-core towards the present day, the relative abundance of ellipsoidal spicules increases. This clear pattern occurs in each of the three reefs which are geographically separate, suggesting a region-wide driver. Ellipsoidal spicules in Bocas are only produced by the demosponges Placospongia intermedia, Geodia gibberosa, and Geodia papyracea that have previously been observed to increase in abundance as reefs degrade. Placospongia and Geodia also represent the principal diet of Hawksbill turtles. The increase in ellipsoidal spicules therefore may have been driven by historical declines in spongivory and/or reef deterioration. A comparative study with reef cores from southern Belize is in process to see if patterns are repeated.

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TESTING DISPERSAL LIMITS IN THE SEA (Abstract ID: 30099)

Biogeographic provinces provide a framework for understanding the origin, distribution, and evolution of species. Here we present a range-wide phylogeographic study of one of the few marine species distributed across all tropical Indo-Pacific biogeographic provinces: the pronghorn spiny lobster, *Panulirus penicillatus*. This species has a nine-month pelagic larval stage and the broadest species distribution of any spiny lobster, extending from the Red Sea to the East Pacific. A fragment of the mtDNA cytochrome*c* oxidase subunit I gene (COI) was resolved in 774 individuals from 28 locations, plus 55 sequences (10 locations) from public databases. Portions of COI, 12S and 16S mtDNA regions were resolved for phylogenetic analyses on a subset of individuals. Phylogenetic and population-level analyses reveal that the Red Sea and East Pacific provinces comprise distinct phylogenetic lineages, divergent at $d$ = 1.1% and 1.8%, respectively. Additional phylogeographic subdivisions align with Indo-Pacific biogeographic barriers. Tropical and temperate regions in the Pacific are significantly differentiated, potentially

indicating an ecological partition. We compare these results with other species that have broad distributions across the Indo-Pacific. Our synthesis provides insight into the drivers of population differentiation in species with seemingly limitless dispersal potential.
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STATUS AND CHANGING TRENDS OF CORAL REEFS IN LAKSHADWEEP ARCHIPELAGO AFTER 1998 MASS BLEACHING EVENT - LONG TERM MONITORING SURVEY (Abstract ID: 27796)

The status of coral health and trends of the coral reef of Lakshadweep islands were not known before the mass bleaching event of 1998. Moreover, the status of the coral reef of Lakshadweep Islands is restricted to qualitative descriptions. Quantitative description on the percentage cover and abundance of the coral species and the benthic substrate composition status of the Lakshadweep reefs are essential for the assessments of reef health and inevitable to create accurate baselines for long-term monitoring. As a preliminary attempt, the status of the coral reefs in 12 atolls of this Archipelago incorporating generic composition and percentage occurrence of different coral species and other benthic substrate types in different atolls have been documented. This baseline information will be of much importance to assess the effect of the natural and anthropogenic alterations in the coral reef ecosystem of these atolls in a long term perspective.

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NUTRIENTS DISTRIBUTION AT TWO DIFFERENT CORAL REEF SITES AROUND SESOKO ISLAND OKINAWA, JAPAN (Abstract ID: 29210 | Poster ID: 441)

Coral reefs are facing various threats of global and local stressors such as ocean acidification, coral bleaching and development of coastal area. Nutrient load is one of the risk factors for deteriorating reef environment. Continuous or frequent monitoring of water quality is needed to predict the future state of coral reefs under the global climate change. Nutrients were monitored every month since 2013 at two different sites around Sesoko Island, Okinawa, Japan. Site A, "Sesoko South", is located off southern part of Sesoko Island where Acropora sp. dominate the coral reef. On the other hand, site B, "Ishikawabaru" is located close to river mouth, fish harbor, resort hotels, aquaculture cage and sewage treatment facility, although coral coverage is 56% in average and more heterotrophic organisms exist. Water samples were taken twice a month at both 2 sites to see the site difference and seasonal variability, and also taken twice a year at broader area around the sites to see the source of the nutrients. There was no seasonality of nutrients at both 2 sites. All the samples showed low level that cannot have an effect on coral growth. Most of the samples were slightly higher at site B than at site A. The sources of nutrients around site B were found to be an aquaculture cage (nitrite), river water (nitrate), sewage facility (ammonium) and land adjacent to costal area (phosphate). The results suggested that the increased nutrients from various sources can influence on the structure of coral reef community at site B and differentiate the structure from site A.

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PHYSIOLOGICAL TRADE-OFFS AND THE LIMITS OF ACCLIMATION AND ADAPTATION OF REEF CORALS (Abstract ID: 30037)

Climate change and direct anthropogenic insults are degrading coral reefs globally at an unprecedented rate. Considering the fragility of reef corals to elevated temperatures and ocean acidification, it has been postulated that under current climatic trajectories, these ecosystems could disappear within a few decades. On the other hand, there is evidence indicating that not all coral species or individual phenotypes within a species are equally sensitive to elevated temperatures and ocean acidification, suggesting that there is a large biological substrate to accommodate successful acclimatization and/or adaptation to future climatic scenarios. In this context, it is important to determine if corals would be capable of retain reef functionality under future scenarios of climate change and ocean acidification. Reef functionality is largely dependent on the capacity of corals to deposit calcium carbonate at rates that exceed those of erosion. Here, I explore the roles played by several physiological trade-offs and constrains on the capacity of symbiotic corals to retain high calcification rates during thermal acclimation and/or adaptation. I will present several models illustrating the effects of strong selection of thermally robust holobionts on community calcification rates, as well as the effects of selecting robust symbionts on the calcification rates of individual species. I will discuss how the selection of traits that provide thermal tolerance, and therefore increasing fitness under climate change, may also compromise the ability of corals to form coral reefs.

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DENSE FISH SCARS AS AN INDICATOR OF PHYSIOLOGICAL VARIATION AMONG MASSIVE PORITES COLONIES (Abstract ID: 28295 | Poster ID: 213)

Grazing by other organisms is considered as one of the important factor that can directly influence coral growth and survival. For example, grazing scar by coral reef fishes in particular has primary influence such as the growth inhibition due to partial mortality of colony while the scar itself can become a potential settlement place for other species. Although one can recognize there are variations among colonies of massive *Porites* in terms of scar density even between two colonies next to each other, there is limited information on the potential cause of such differences. Therefore, in this study, we aimed to elucidate the cause of such variation by conducting field observations as well as experiments. We first conducted field dive survey at 36 sites within Sekisei Lagoon, Okinawa, Japan. During the survey, 48 colonies were measured for their in-situ maximum quantum yield of symbiotic Zooxanthella (maximum photosynthetic efficiency; *Fv/Fm*). Also, each colony was digitally photographed for the calculation of "grazing scar ratio" utilizing ImageJ software. We hypothesized that "grazing by fish is performed randomly but scar healed faster in these colonies with greater growth rate that resulted in fewer grazing scars in certain colonies". To examine the relationship between growth rates versus scar density in the field condition, we conducted series of experiments testing the growth rates of nubbins from massive *Porites* with various scar conditions. Based on the results, we'll discuss potential implication of various scar densities among massive *Porites*.

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FISHERY IMPROVEMENT PROJECT (FIP): AN EFFECTIVE DELIVERY MECHANISM OF EAFM PRINCIPLES TO IMPROVE CORAL REEF FISHERIES MANAGEMENT (Abstract ID: 29316)

This paper draws from the experiences and lessons learned in the implementation of Fishery Improvement Projects (FIP) showing the delivery of EAFM principles to improve fisheries management. FIPs advocates a stepwise process to improve the fisheries performance to a level consistent with a conditional pass against the Marine Stewardship Council (MSC) Standard within a prescribed period. Fishery improvements are identified through a pre-assessment of the fishery against three MSC principles of i) stock status, ii) ecosystem impacts of the fishery and iii) the governance system and provides the basis for actions needed and agreed to by stakeholders via a transparent consultation process. Experiences show that addressing the management and governance issues and adherence to a science based policy and decision making processes are the two major challenges of FIP and EAFM. The strategy to overcome these challenges hinges on coordinating and harnessing the full potential of stakeholders while providing economic incentives that ensure participation. FIP as a framework deliver much more than EAFM: provides the flexibility to incorporate the socio cultural and economic aspirations using existing EAFM tools to achieve livelihood retention and improved fishery value. In addition sustainable financing mechanism that harness the power of markets could be built into the design of an FIP. To date there are few examples of FIP applied to coral reefs that are in various stages of development: the Bahamas lobster fishery and the Koon snapper fishery of Indonesia.
http://wwf.panda.org/what_we_do/where_we_work/coraltriangle/

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USING CONCEPTUAL ECOSYSTEM MODELING TO SUPPORT ECOSYSTEM-BASED MANAGEMENT IN WEST HAWAI'I (Abstract ID: 29542 | Poster ID: 603)

The west coast of Hawai'i Island faces myriad threats related to environmental stress, population increase, and a rapidly changing climate. These compromise the region's capacity to deliver ecosystem goods and services critical to human wellbeing. The problem's complexity and region's ecological and economic importance prompted NOAA's Pacific Islands Fisheries Science Center to initiate an Integrated Ecosystem Assessment (IEA), a program focused on conducting scientific research to support ecosystem-based management. Initial IEA phases involve comprehensively characterizing system components and identifying monitoring indicators that span the social and ecological system. Workshops with resource managers, scientists, and community members from 2014-2016 developed conceptual ecosystem models (CEMs) guided by the Driver-

Pressure-State-Impact-Response framework. The participatory process engaged a broad base of stakeholders, with special emphasis on gathering and synthesizing place-based knowledge. The resulting CEMs identify natural and anthropogenic stressors affecting different ecological states (e.g., reefs, water body), ecosystem services, and relationships among system components. Participants also weighted relationships and assigned indicators. These are the first CEMs for West Hawai'i and will directly inform how we research and manage the region. CEMs can help clarify the decision context, integrate stakeholder values, and reveal gaps in scientific information needed to support decision-making. They constitute an important phase of the IEA.

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POTENTIAL AND BOTTLENECKS OF MONITORING CORAL REEFS FROM SENTINEL 2 IMAGES (Abstract ID: 30056 | Poster ID: 541)

Monitoring coral reef ecosystems over large-scale areas and long-term periods can be successfully achieved if remote sensing images, ground truth data and automatic image processing algorithms are available. The increasing availability of Earth observation images acquired by the Sentinel 2 satellites opens attractive opportunities for coral reef monitoring as it provides freely accessible high resolution images with a complete coverage of the Earth's surface every ten days. This huge amount of data acquired by the same sensor under the same view angle enables accurate detection of real changes of the surveyed ecosystem. This paper presents an exploratory approach to monitor coral reefs from Sentinel 2 imagery. The proposed approach exploits deep convolutional networks for mapping a predefined typology of coral reefs on Sentinel 2 images and exploits temporal imagery for monitoring purposes. The approach is validated on Sentinel 2 images of New Caledonia. Results show the capacity of the proposed approach for mapping purposes and highlight the potential of Sentinel 2 imagery for monitoring.

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ENGAGING DIVE TOURISM IN SUSTAINABLE FINANCING AND CORAL REEF DATA COLLECTION FOR BETTER MANAGEMENT OF KARIMUNJAWA NATIONAL PARK, INDONESIA (Abstract ID: 28657)

Indonesian coral reefs cover an area of almost 40,000 km2, scattered over thousands of islands. These geographical conditions, compounded by limited marine scientists and funding for coral reef monitoring, create challenges for understanding and management of Indonesian coral reefs. Widespread development of the diving industry presents an opportunity to address these challenges. This study was conducted in Karimunjawa National Park (KJNP) from 2006 to 2013. In 2006, Diponegoro University - Marine Diving Club (MDC), KJNP authorities and partners established Reef Check EcoExpeditions (RCE). These coral reef monitoring expeditions were conducted annually and a significant percentage of the costs were covered by paying dive voluntourists. RCE generated an average of 2,187 USD/year, funds which were critical for covering Reef Check survey activities in the park. In total, 107 divers were certified as Reef Check monitoring personnel and contributed coral reef monitoring data at five sites within the park. Over the seven years data collection, hard coral live coverage increased from 47% to 54%, and declining snapper and grouper populations were recorded. These declines were driven by increased fishing pressure, in part to support demand for reef fish as a result of increased tourism. The coral reef health data served as the primary data guiding KJNP authority management actions. The KJNP study was the pilot site for Reef Check tourist diver certification system in Indonesia, and it has since inspired a number of universities to adopt the same system.

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MID-TO-LATE HOLOCENE SEDIMENT DYNAMICS AND DRIVING MECHANISMS IN A MIXED CARBONATE-SILICICLASTIC LAGOON (BORA BORA, FRENCH POLYNESIA, SOUTH PACIFIC) (Abstract ID: 28146)

A multi-proxy approach applied to sediment cores from the mixed carbonate-siliciclastic lagoon of Bora Bora was used to detect palaeoenvironmental changes and to evaluate controlling mechanisms of sediment dynamics during the mid-to-late Holocene. The increase in coarse-grained and clay-sized sediments, productivity, XRF Ca counts and decrease in XRF Cl counts over the past 5 kyrs seem to indicate event deposition and can be correlated with event deposits in nearby Tahaa lagoon explained by higher cyclone activity. Based on this model, intense rainfall during cyclone landfall would enhance erosion and run-off from the volcanic hinterland and lower lagoonal salinity. Reefal sediment would be transported into the lagoon. However, the Ti/Ca proxy for terrigenous input has decreased steadily during that time period. Also, benthic foraminifera assememblages do not indicate reef-to-lagoon transport of sediment. Alternatively, more permanent southeast trade winds during the mid-to-late Holocene could have favored higher hydrodynamic energy conditions, flushed higher amounts of open ocean water and pelagic organisms into the lagoon, enhanced marine productivity and lowered lagoonal salinity. Our alternative model of long-term lagoonal sediment dynamics includes mid-to-late Holocene sea-level change and lagoonward progradation of sand aprons. The observed lagoonal sedimentation patterns during 4.5-0.5 kyrs BP reflect intensified sediment dynamics and gravity-induced slumping at sand apron/lagoon edges due to oversteepening during ongoing progradation. Additional analyses and age dating are in progress and will help to constrain the interpretation summarized here.

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CORAL REEF STATUS AND BLEACHING INTENCITY AT ST. MARTIN ISLAND, BANGLADESH. (Abstract ID: 28275)

St. Martin island and adjacent location is only coral habitat in Bangladesh. Although not much rich more than 70 species have so far been identified under 22 genera. The multidimensional threats prevailing in the island coral ecosystem, more due to recent development and tourism initiative rather than island anthropogenic impact. Current manmade major problems are sedimentation, plastic pollution, anchor damage and coral mining. Global worming intensifying coral bleaching along with the entire world tropical coral habitat. Bleaching has been recorded in 1998, 2008 and in last several years with small scale. At least 5-8 large vessel operates during tourist season Oct-April each year with transportation of several thousand each day make huge plastic disposal in the sea that has no control yet in place. The vessels anchor nearshore that create extreme sedimentation. Large number of plastic items and huge sedimentation recorded in Nov-Dec 2015 coral survey. There is no sewage and toilet systems suitable for coral habitat in the island. Marinelife Alliance, research and conservation NGO is trying to establish locally managed MPA at south and west nearshore area with a span of 1200 acres. Annually underwater cleanup and coral habitat protection by community is underway. There is much need of international support both financial and technical to manage the coral habitat of St. Martin island. International volunteers and students are invited to join in annual survey and threat reduction. At least 90% coral coverage has bleached recorded in last Nov 2015 survey.
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IMPLICATIONS OF THE ROLE OF HYBRIDIZATION IN SPECIATION OF THE GENUS *ACROPORA*: FEATURES OF REPRODUCTION OF HYBRIDS IN THE INDO-PACIFIC SPECIES (Abstract ID: 28116)

Hybridization of the Indo-Pacific reef-building corals, particularly the most dominant genus *Acropora*, is assumed to have occurred through multi-specific synchronous spawning events. However, natural $F_1$ hybrids have never been documented in the Indo-Pacific corals and the role of hybridization remains unknown. In this study, we succeeded repeatedly to observe the spawning of two $F_1$ hybrid corals, which were produced experimentally from the two Indo-Pacific species, *A. intermedia* and *A. florida*. One colony ("FLOint") is from the egg of *A. florida* and sperm of *A. intermedia* and the other ("INTflo") is from the reciprocal cross. They spawned at the same timing of the parent species. However, their fecundities were clearly different: high in FLOint, but very low in INTflo. In case of FLOint gametes, backcrossing with parent species was successful, but self-fertilization rate was high (>90%). Selfing is plausible to have advantages when available gametes for fertilization are low: hybridization may be one of good strategy to survive in case of low population density. These data suggest that in the Indo-Pacific *Acropora*, $F_1$ hybrid can reproduce via not fragmentation but self-fertilization: However, hybrids may have a risk for re-fusion into another species in future by backcrossing with parent species, depending on the eggs of which species is from.

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THE POTENTIAL FOR SUMATRA EARTHQUAKES AND TSUNAMI RECONSTRUCTION USING *PORITES* CORAL SKELETONS FROM SIMEULUE ISLAND, INDONESIA. (Abstract ID: 28550 | Poster ID: 394)

The great (M 7-9) subduction-zone earthquakes have occurred along Sunda megathrust during recent several hundred years. In Sumatra, Indonesia, two earthquakes occurred on 26th Dec 2004 (M 9.2) and 28th Mar 2005 (M 8.7). These earthquakes triggered giant tsunami, coseismic uplift and subsidence in the rupture area. Here we show the potential for reconstruction of the coseismic events (uplift, subsidence and tsunami) using geochemical analysis and skeletal microstructural observation in Porites coral skeletons collected from Simeulue Island, Indonesia. Simeulue Island was reported that the northwest part uplifted max 145 cm in 2004 and the southeast part uplifted max 165 cm in 2005. Coseismic uplift and subsidence would change the light availability for reef corals, which have the relationship with coral skeletal carbon isotope ratio. The tsunami would also have influenced on habitat of reef building corals, it would caused by high turbidity due to fling up sea bottom muddy sand and terrestrial runoff. We collected coral cores at four sites of Simeulue Island in 2010. Coral annual extension rates in pre-earthquake were significantly higher than that in post-earthquakes. At the northwest coral (uplifted 142 cm in 2004), the variation of skeletal carbon isotope ratios was characterized by large amplitude after the earthquakes. Moreover, one of our coral specimens had a characteristic band so-called green band, which corresponded to the timing of tsunami occurrences. We propose that coral skeletons are the potential proxy for earthquake and tsunami during several hundred years.

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DIFFERENCES IN CRYPTIC DIVERSITY AND HOST SPECIFICITY OF COPEPODS ASSOCIATED WITH STONY CORALS IN THE RED SEA (Abstract ID: 29154 | Poster ID: 67)

More than 340 species of Scleractinia-associated copepods (Crustacea) have been described so far, but not from the Red Sea. They usually occur in multiple associations and show a high degree of host specificity. We collected symbiotic copepods from 189 colonies of stony corals at 0.5-40 m depth in the south and the middle of the Saudi coast of the Red Sea. We conducted an analysis of nuclear and mitochondrial markers (ITS & COI) of (i) all morphotypes of copepods associated with 13 species in 9 genera of the family Fungiidae and (ii) copepods of the genus Spaniomolgus (Poecilostomatoida) living in association with Seriatopora hystrix and various morphotypes of Stylophora. The results of tests on DNA taxonomy (e.g. GMYC, PTP, and ABGD) will be presented to detect independently evolving lineages that could be considered as representing different species. Moreover, results of exploratory tests on phylogenetic comparative methods will be presented to highlight the levels of association between species of copepods and host corals.

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LINKING MANAGEMENT PERFORMANCE TO POSITIVE ECOLOGICAL OUTCOMES IN THE RAJA AMPAT MARINE PROTECTED AREAS, INDONESIA (Abstract ID: 29730 | Poster ID: 656)

An increasing number of Marine Protected Areas (MPAs) has been established in the last decade in response to threats such as overfishing and habitat destruction. However, in order for MPAs to provide the ecological and social benefits they were designed for, there must be effective management in place. Using quantitative methods, this study investigates whether there were significant changes in fish biomass, fish size and percentage of hard coral cover in six MPAs in Raja Ampat, Indonesia. It further investigates the relationship between management strategies and changes in these three ecological indicators. A temporal analysis was carried out using baseline and repeat monitoring data as well as annual management scores using the World Bank Scorecard methodology. Dampier, Missol and Kawe MPAs had significant positive changes in fish biomass, average fish size and percentage of hard coral cover values. Results from the World Bank Scorecard assessments indicate that management of Raja Ampat's MPAs has overall improved from 2012 to 2014. These results indicate that there has been an effort to better manage the MPAs in the BHS, which may be correlated to increasing values of ecological outcomes. The findings of this study may help MPA managers and decision makers developing better strategies and improving MPA management to effectively achieve conservation objectives.

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EXPRESSION PATTERN OF CYTOCHROME P450 AROMATASE GENE DURING SPAWNING PERIOD IN *ACROPORA TENUIS* (Abstract ID: 28524 | Poster ID: 177)

Most scleractinians including *Acropora* species accumulate yolk into their oocytes during spawning moon phase. It is considered that yolk accumulation (vitellogenesis) occurs physiologically under stimulation of hormones and neurotransmitters, although it is not fully understood how vitellogenesis is regulated endogenously. Cytochrome P450 aromatase is known as a rate-limiting enzyme converting androgen to estrogen and plays a role in physiological processes in vitellogenesis of oviparous species. The present study aimed to clone and characterize cytochrome P450 aromatase (*atArom*) cDNA of *Acropora tenuis* in Okinawa, Japan, and evaluate its expression during the spawning season (May through July). The isolated cDNA clustered with aromatase of other invertebrates, suggesting that the aromatase of *A. tenuis* was successfully cloned. Monthly collection of *A. tenuis* around the full moon period revealed that this species releases their gametes in May and June. mRNA abundance of *atArom* in the samples from May through October was measured using quantitative polymerase chain reaction, and was higher during the pre-spawning period than during the post-spawning period. This expression pattern of *atArom* mRNA is in agreement with the histological appearance of oocytes laden with yolk in the polyp. It is concluded that estrogen (perhaps estradiol-17b) is closely related to the final stages of oogenesis in *A. tenuis*.

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THE IMPORTANCE OF HABITAT CONNECTIVITY AND PROTECTION ON NURSERY REEF FISHES IN THE PHILIPPINES (Abstract ID: 29280)

Several studies on reef-associated fish species show evidence of ontogenetic habitat shifts among seagrass beds, mangroves, and coral reefs during their life stages (nursery species). In the Caribbean region, the availability of mangrove nursery grounds influenced the community structure and biomass of reef fishes in their adult stage. However, information to demonstrate similar ecological processes underlying ontogenetic habitat shift along the mangrove-reef habitat continuum has only started to accumulate in the Indo-Pacific region. Here, we validate ontogenetic habitat shift by some reef fishes in the Philippines based on their proximity to mangrove habitats and, hence, provide additional data for the Indo-Pacific region. It attempts to verify the hypothesis that high biomass with well-defined size structure may be attributed to a highly connected coral reef and mangrove habitats through ontogeny. Further, the study aims to determine if there is difference in community assemblage and biomass of these nursery species between protected and unprotected reefs to show the benefits of protection in biodiversity conservation with value added information as regards the synergism between protection and habitat connectivity. This study therefore highlights the contribution of this connectivity to the coral reef fish species diversity in the Philippines widely acknowledged as the center of high marine biodiversity in the world. Results of the study are discussed along these lines of ecological framework.

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GOOD GOVERNANCE INCREASES CORAL REEF RESILIENCE (Abstract ID: 28699)

Reef corals are declining worldwide due to local stressors and global climate change but the ways these different factors interact to reduce coral abundance remain obscure. We analyzed data from more than 35,000 surveys to document ecological changes on reefs throughout the wider Caribbean from 1970 to 2012, and then compared local differences in the status and trends of coral populations in relation to local differences in fishing pressure, human population density, and thermal stress. Average coral cover declined by half by 1990 with little subsequent decline, while macroalgal cover increased more than three fold in the 1980s and early 1990s and has remained high. These early losses were principally due to outbreaks of disease and overfishing a decade before the first regional episodes of sustained thermal stress and coral bleaching. In contrast, more recent losses of corals following extreme thermal stress varied among locations as a function of fishing pressure, the abundance of macroalgae, and concomitant susceptibility to disease. These differences are strongly related to basic socioeconomic indicators with quality of governance, GDP, and fishing regulations the most important factors. Our results support the hypothesis that local protections can increase reef resilience in the short term pending global action on climate change.

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METABOLIC SCALING IN COLONIES: THE INFLUENCE OF INTEGRATION (Abstract ID: 29117)

From single celled bacteria to complex multicelled vertebrates, intraspecific variation in metabolism commonly scales allometrically, but with considerable variation. Here, I investigate if and how scaling relationships in colonies vary with the degree of integration. Clones can live in different states: a loosely associated group, a highly integrated colony, and eventually transition into a fully integrated individual. I hypothesized that highly integrated colonies are more likely to exhibit standard metabolic scaling (allometric, with exponent = 3/4), as is observed in fully integrated individuals. Furthermore, loosely associated groups of clones are more likely to scale isometrically (exponent=1) because the addition of new clones should not affect the metabolism of the other group members. The effect of colonial state on metabolic scaling was tested using ~100 taxa, including Arthropods (24), Bacteria (7), Bryozoans (8), Chordates (9), Cnidarians (37), Plants (4), and Protozoa (5). While colonial state and phyla are poor predictors of the scaling exponent, the scaling exponent generally decreases with integration, from 0.97 +/- 0.08 in loosely associated groups, to 0.90 +/- 0.07 in highly integrated colonies, and to 0.85+/-0.06 in fully integrated individuals. Thus, increases in integration are associated with a shift from isometry to allometry. In theory, an increase in integration indicates a transition in individuality, but integration is difficult to quantify. Thus, metabolic scaling exponents can represent a continuous measure of a transition in individuality.

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PHAGE THERAPY FOR DISEASED CORALS? POTENTIAL OF A NOVEL GIANT VIRUS AS ANTIMICROBIAL AGENT AGAINST CORAL PATHOGENS (Abstract ID: 29296 | Poster ID: 164)

Coral reefs are amongst the most biologically diverse and productive ecosystems on Earth and provide economic goods and ecosystem services through fisheries and tourism. The health of these fragile ecosystems is severely threatened by the combined effect of anthropogenic pressure and global climate change. The increased surface water temperature and pollution have been associated with the development of diseases leading to the demise of infected coral reefs. Extensive research is currently dedicated to characterizing the causative agents of the coral disease and, in most of the case, the identified pathogens are bacteria. It is however equally important to investigate procedures to cure and prevent these infectious diseases. Over the past 5 years, the use of phages as biocontrol agents to treat bacterial mediated disease has emerged as a promising tool to inhibit the progression of coral infection but also its transmission to healthy counterparts. To further investigate the usefulness of phage therapy, it is nowadays necessary to describe the biological traits and ecological functioning of phages candidates. In this study, we isolated a novel giant phage that specifically kills a causative agent of coral bleaching, Vibrio coralliilyticus. We will present a genomic and functional analysis of this bacteriophage and discuss the effectiveness of these parasites as therapeutic agents for diseased corals.

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MORE SHARKS, LESS FINS: ECOLOGICAL SUCCESSES AND SOCIO-ECONOMIC CHALLENGES OF SPATIAL PROTECTION WITHIN THE WORLD'S BIGGEST SHARK FISHERY (Abstract ID: 29472)

Despite the popularity of spatial closures as a tool to address conservation goals, little is known about the effectiveness of shark-specific closures to protect sharks, or their impacts on fisher behavior. Situated within the Coral Triangle, Indonesia's shark fishery contributes more to the international shark fin trade than any other nation. We assessed shark diversity and abundance in an open access zone (OAZ) and two No-Take Zones (NTZs) of a Marine Protected Area within the recently established shark sanctuary in Raja Ampat, eastern Indonesia, where sharks have high monetary value. Shark abundance was significantly higher in the privately managed NTZs than in the OAZ. Across all management zones, neither zone size, depth nor reef complexity explained variations in shark abundance, suggesting that governance is the main driver of successful shark conservation areas. Interviews with shark fishers showed that while most fishers knew that sharks were protected in their former fishing grounds, few felt that the agencies implementing fishing bans understood their livelihood needs. We found that fishers adapted to the loss of fishing grounds by shifting fishing effort to other locations or diversifying their livelihoods, including illegal petrol transport. While conserving sharks for tourism can be effective, it may inadvertently result in displacing fishing effort to unprotected regions. We propose that where shark fisheries support important livelihoods, effective shark conservation should combine strategic spatial protection with support for livelihood diversification.

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MANAGING NATURAL RESOURCES THROUGH VULNERABILITY ANALYSIS: AN APPLIED CASE STUDY INTO RECREATIONAL ACTIVITIES AT CORAL REEFS IN PUERTO RICO (Abstract ID: 29683 | Poster ID: 589)

Coral reef related tourism and recreational activities rank among the most important industries by providing jobs, supporting local economies, increasing visitor knowledge of coral reefs, promoting pro-environmental values and helping to create a conservation ethic. However, research has demonstrated that marine recreational activities like snorkeling and diving can also degrade coral reefs when visitors act inappropriately. Damage to the reef is often the result of inappropriate behaviors of individuals and not the industry. Given the current and expected growth in tourism and marine recreational activities, the problem of recreationally-based damage to coral ecosystems can cause significant damage. In Puerto Rico not enough is known about the type of stress recreationalists place on reefs, what management actions are available, or how effective they will be at mitigating impacts. This presentation aims to share knowledge about these areas by presenting a methodology developed to assess the vulnerability of select coral reefs to recreational activities within La Cordillera Reserve, Puerto Rico.

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EFFECTS OF ACUTE AND CHRONIC CHANGES IN SALINITY AND LIGHT ON THE BLEACHING AND RECOVERY OF THE STAGHORN CORAL, ACROPORA MILLEPORA (Abstract ID: 29902 | Poster ID: 360)

In this study, both acute and chronic tests were conducted to determine whether light intensity and salinity triggered bleaching of coral, Acropora millepora. Five treatments of light (0, 1000, 3000, 10000, and 30000 lux) and five treatments of salinity (20, 25, 30, 35 and 40 psu) levels were used. The results of the acute light intensity experiment revealed that color of A. millepora reduced significantly within 8 days under the highest light intensity level (30000 lux) compared to other light intensity levels. Similar to light intensity experiment, A. millepora colonies turned into pale colors, and were bleached in 2 days under the highest salinity level (40 psu). In addition, the corals showed signs of tissue slough-off. The results from the chronic tests showed that under light and salinity conditions, corals tended to have more tolerance than that of in the acute experiments. At the end of the experiments, all experimented corals were brought to the normal condition for a recovery. The results showed that bleached corals under the light experiments were able to recover 100% while experimented corals under the salinity experiments were not able to recover or had lower recovery rates. Moreover, from the molecular genetics analysis, zooxanthellae found in all experimented corals both before and after the experiment trials were clad C1. Therefore, zooxanthellae clad may not play an important role on susceptibility of the corals to the bleaching in this study.
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DIVERGENT REEF CARBONATE BUDGET TRAJECTORIES FOLLOWING A MAJOR CLIMATIC DISTURBANCE EVENT (Abstract ID: 28538 | Poster ID: 238)

Climate warming and associated increases in the frequency or intensity of stressors is one of the greatest threats to coral-dominated tropical ecosystems. For example, warm water events have caused major coral bleaching and associated mortality events, and are predicted to do so with greater intensity and frequency. While the ecological ramifications of such events have been widely explored, to date the geological and geomorphological implications are poorly understood. Here, using a census based technique, we track the biological carbonate budget of 21 reefs of the inner Seychelles from 1994 to 2014, across the impact of the 1998 bleaching event, where up to 90% of coral cover was lost. All reefs had a positive carbonate budget in 1994, but by 2005 all reefs had a negative budget. Reefs then followed two distinct trajectories: 14 reefs remained in an erosional condition despite some increases in coral cover, while 7 reefs regained a net positive budgetary state within 10 years of bleaching, and a similar budget to pre-bleaching reefs by 2014. Using boosted regression trees, we identified that reefs with no macroalgae, higher massive coral cover, low wave exposure and lower excavating parrotfish biomass (< 90kg/hectare) in 1994 were more likely to recover to a positive budgetary state. While in 2014 the recovering reefs attained a similar positive budget to 1994, the present overall greater biomass of excavating parrotfish, increased macroalgal cover and lower massive coral cover makes it unlikely that similar recovery trajectories will occur after future bleaching events.

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RELOCATION OF CORALS AND ASSOCIATED FAUNA LOCATED IN THE DREDGING AREA OF THE ACCESS CHANNEL TO CARTAGENA BAY (Abstract ID: 29764 | Poster ID: 437)

In order to mitigate the environmental impacts due to the implementation of deepening dredge in the access channel to Cartagena bay (Colombia), the Environmental Management Plan approved involved the relocation of 8,725 individuals belonging to 15 marine species of ecological importance in the area. Among the relocated species, it was found corals, antipatharians, sponges, sea urchins and fish. Within six months of moving the fauna and by the repeated measures analysis of variance, it was established that the areas where the fauna was entered have not suffered a statistically significant change in biotic and abiotic cover ($p > 0.05$) but it does have for algal cover and density of invertebrates and fish ($p < 0.05$). This significance was given by the increase in density at the six months monitoring compared to that found at the one month monitoring after the relocation. This pattern in density may be related to the increased availability of food, since most of the observed organisms feed on algae, which increased their coverage. In addition, within six months of the relocating process the corals and sponges have a survival percentage of 86% for the former and 57% for the latter. The results obtained indicate that the actions implemented to mitigate the impact of dredging on this ecosystem in the area were appropriate, ensuring the survival of more than 50% of individuals that were moved without alter in an ecological way the habitats to which they were entered.

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AN ASSESSMENT OF THE DIVERSITY OF ZOANTHARIANS FROM ECUADOR USING AN INTEGRATIVE APPROACH. (Abstract ID: 29442 | Poster ID: 58)

Zoantharians (Cnidaria, Order Zoantharia) represent a group of marine invertebrates that are distributed from shallow waters to the deep sea worldwide. They are especially diverse and abundant in the rocky reefs of the Pacific Ocean and, as such, they are key elements of the marine biodiversity shaping ecosystems in these areas. Few reports on the diversity present of the mainland coast of South America and especially of the coast of Ecuador exist despite its high interest as a zone of confluence of two main Pacific currents. The taxonomy of zoantharians is highly challenging due to a lack of clear morphological characters and in recent years, molecular techniques have helped clarify high level-taxonomic relationships within the order. However, many issues remain at species level due to the limited resolution of the DNA markers commonly used. In this context, the use of a metabolomics approach shows promise to help distinguish closely related morphotypes in related temperate zoantharians and especially amongst Zoanthus spp. We applied an integrative approach to classify Ecuadorian species and here we will present preliminary data on the diversity of zoantharians present in the Marine Protected Area "El Pelado" in the province of Santa Elena, Ecuador. Importantly a metabolomics approach involving UHPLC-HRMS proved to be useful as a complementary tool for their classification. A global comparison with well-known species of the Western part of the Pacific (Okinawa) revealed very few similarities between zoantharians present in both parts of this Ocean.

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MOLECULAR PHYLOGEOGRAPHY AND POPULATION STRUCTURE OF BELIZEAN SEA CUCUMBERS (Abstract ID: 29693 | Poster ID: 54)

Sea cucumbers are fairly inconspicuous animals that live on the ocean floor and gain nutrition from diatoms, bacteria, and detritus associated with the sediment they ingest. Sea cucumbers perform vital ecosystem services by recycling nutrients and aerating the upper sediment layers. The biology, ecology, and taxonomy of commercially exploited sea cucumber species are poorly understood in Caribbean and Central American countries where the bêche-de-mere fishery is fairly new and inconsistently regulated. We report preliminary findings of sea cucumber species diversity and within species genetic variation along the Belize Barrier Reef. We wish to determine the extent of genetic variation in these exploited sea cucumber populations and the role MPA's may play in maintaining genetic diversity on the reef.

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THE 26 YEARS OLD CAPTIVE REEF KEPT AT THE MONACO'S OCEANOGRAPHIC MUSEUM (Abstract ID: 29443 | Poster ID: 480)

The Monaco's Oceanographic Museum harbors one of the (and perhaps the) oldest captive reefs in the world. This reef was set up in 1989. It was made of live stones, live sand and live corals as well as fishes collected in the Gulf of Tajoura (Djibouti, Indian Ocean), shipped to Monaco and used to stock a 40,000 liters semi-closed aquarium. The aquarium is almost entirely ecologically balanced (JAUBERT NNR SYSTEM). The hard corals (massive, branching and foliose species) have built a life size patch. The patch, which is still thriving today after 26 years of uninterrupted development, is as beautiful as the most beautiful coral patch that one can see in nature. Therefore, while coral reefs are under heavy pressures because of overexploitation, pollution, global warming and ocean acidification, this successful experiment opens interesting prospects of ex situ conservation. By multiplying examples of this kind in public aquariums one might contribute to make an increasing number of people undoubtedly sensitive to the importance and beauty of coral reefs and to the need to conserve them.

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TWO NMFS CONSULTATION CASE STUDIES IN PACIFIC AND CARIBBEAN CORAL REEF ECOSYSTEMS TO AVOID AND MINIMIZE CORAL REEF IMPACTS (Abstract ID: 30114)

In both the U.S. Pacific Islands and the Caribbean, natural resource agencies review water resource development projects proposed along the coast. A growing interest in renewable energy production and telecommunication installations in the Pacific and Caribbean Islands has led to a number of permit applications for new types of projects that include construction offshore. The first case study, the Honolulu Air Conditioning Project, is an example of an innovative renewable energy project that proposes to draw cold water from deep offshore waters and pipe it to land to help generate air conditioning for buildings in downtown Honolulu. Resource agencies were concerned about the associated proposed discharge of very large amounts of the cold, nutrient-rich return water to the nearshore coral reef environment. Through early consultation with the permitting entities and natural resource agencies the applicant redesigned the project to discharge return water in deep waters outside the depth range of coral reef habitat. The second case study focuses on two sites in San Juan, Puerto Rico, that are hubs for submarine cable projects connecting the Caribbean, South America, and the continental U.S. NOAA Fisheries has worked with the U.S. Army Corps of Engineers to create standard conditions for submarine cable projects due to the increase in submarine cable projects in the U.S. Caribbean over the last 15 years, the listing of 7 Atlantic coral species

under the Endangered Species Act, and the importance of shallow and mesophotic reef systems as fishery and coral habitat along many cable routes. Standard conditions related to survey methods to establish temporary anchorage areas and site the cable routes in shallow and deep water and cable laying requirements to minimize potential coral impacts have been developed. The outcomes of these consultations have led to a reduction in damage to coral resources, while allowing economic growth to continue in the U.S. Caribbean and Pacific.

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EMPLOYING SOFTWARE ENGINEERING PRINCIPLES TO ENHANCE ANALYSIS OF CORAL REEF DATABASES (Abstract ID: 29768)

In order to answer questions in a coral reef context, we have created a framework that reduces the overhead of continual data preparation and allows more time and resources for scientific inquiry. Directly employing software engineering principles, this framework improves data access, connectivity, and scalability with consideration for privacy and security by introducing an abstraction between the data management layer and the application layer. Using the software repository pattern, this solution offers a decentralized data service for use with minimal up-front data processing. In our presentation we will use this framework to analyze a complex data set consisting of twenty corals and seventeen environmental factors collected at fifty reef sites over a span of four years. One goal is to determine if the presence of a particular coral facilitates growth of other coral species and recruits. Using our software framework we are able to look at the incomplete data and expose how much of the picture is missing. Furthermore, this platform allows us to exhaustively search the space of coral associations and test all relationships. This yields statistically significant evidence that one coral species is conducive to growth and recruitment of other species in the Caribbean. We argue that much of the success in answering this and other complex ecological questions stems from our robust data management framework which will allow us to evaluate the potential implications of species and environmental associations on a larger scale to address coral resilience.

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FUSION OF CORAL EMBRYOS: A POTENTIAL AND UNEXPECTED SHORTCUT TO COLONY FORMATION (Abstract ID: 28590)

Juvenile coral colonies originate either from the asexual budding of the primary polyp, or fusion of gregariously settling larvae and adjoining recruits. Here, we observed for the first time the inborn juvenile colonies resulting from fusion of embryos and the following settlement of conjoined larvae in a broadcast spawning reef coral Platygyra daedalea. We hypothesize that fusion of coral embryos might be a potential and unexpected shortcut to colony formation, and meanwhile an adaptive strategy to form pre-metamorphic chimeric larvae and larger recruits in reef corals, thereby promoting early survival. Future studies are required to explore whether fusion of embryos is common in broadcast spawning corals and occurs in the field, and fully evaluate its implications.

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MEASUREMENTS OF UNDERWATER CARBONATE CHEMISTRY USING A PROTOTYPE HYBRID AUV/ROV AND AUTOMATIC SENSORS: A DEMONSTRATION PROJECT (Abstract ID: 29903)

Knowledge of deep-water carbonate chemistry remains limited, largely due to the limitations of observational capabilities. Here we present results from a 6-day (Aug. 8-13, 2015) survey along the east coast of Florida using a new hybrid AUV/ROV U-4000 outfitted with state of the art biochemical sensors, and a high-definition imaging system. The U-4000 is a flat rectangular platform designed to operate in an autonomous mode or a supervised autonomy mode using a self-spooling, fiber-optic tether. In this project, the vehicle was outfitted with CTD, SAMI-pH, HydroC pCO2, and DO sensors to characterize the carbonate chemistry and water conditions. The pCO2 and pH sensors sampled at 1 and 5 min. interval, respectively. The vehicle was deployed 11 times at 6 dive sites from nearshore (~15 m) to shelf edge (~75m). Nine CTD casts were made with a mini-rosette to collect water samples for measurements of total CO2, alkalinity, and other parameters. The U-4000 performed reasonably well on various operations such as diving, climbing and mosaicking at sites with weak currents (<0.5 m/sec), but having difficulty of moving against strong currents. Further enhancements of the vehicle are ongoing. A preliminary analysis indicates that the sensor data were in good agreement with sample data. For the two shelf edge sites in the vicinity of the Oculina HAPC and within the Gulf Stream frontal zone, the pH, pCO2, and aragonite saturation state (omega) all show a wide range of values with pH from 8.07 to 7.96, pCO2 from 300 to 600 µatm, and the omega from 4.0 to 2.4 from surface to bottom.

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A GALNAC-BINDING LECTIN COULD BE INVOLVED IN ACQUISITION OF *SYMIODINIUM* BY *ACROPORA TENUIS* (Abstract ID: 29382 | Poster ID: 118)

Many corals often harbor symbiotic dinoflagellates, *Symbiodinium* spp., and their symbiosis is indispensable for the survival of corals. However, they often acquire *Symbiodinium* around their environment, and this acquisition was inhibited by some carbohydrates, suggesting that a carbohydrate binding proteins may play a role in this step. So we purified a lectin using a hard coral *Acropora tenuis*. The juvenile polyps of *A. tenuis* acquire *Symbiodinium* strain NBRC102920, and this acquisition was inhibited by galactose, *N*-acetylgalactosamine (GalNAc), and *N*-acetyl-glucosamine. By GalNAc-affinity chromatography, two components at 29.0 kDa and 14.6 kDa were purified. *De novo* sequencing by MALDI-TOF MS spectrometry suggests that 29.0 kDa component is similar to a GalNAc/GlcNAc binding lectin tachylectin-2 (TL-2) purified from a horseshoe crab, which is involved in immunity. Based on the sequence, the corresponding cDNA was cloned. The deduced amino acid sequence was composed of 267 amino acids, and had a similarity to TL-2 and some putative proteins from *A. digitifera* genome database, so the protein was named to AtTL-2. Immunohistochemistry of *A. tenuis* tissue suggests that AtTL-2 distributed a kind of nematosysts. Moreover, Anti-TL-2 antibody inhibited *Symbiodinium* acquisition by juvenile polyps. These results let us to hypothesize that *A. tenuis* may acquire *Symbiodinium* near themselves by releasing AtTL-2 from nematocysts.

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UNUSUAL FEATURES OF A MESOPHOTIC HARD CORAL ASSEMBLAGE IN A LAGOON ENVIRONMENT DOMINATED BY HEAVY TERRIGENOUS SEDIMENTATION: THE BANC GAIL (SW NEW CALEDONIA). (Abstract ID: 28630)

Mesophotic coral assemblages are most often developed on the deep fore reef slopes exposed to oceanic conditions. Less common are the mesophotic assemblages which occasionally occur within the confines of large lagoons where environmental conditions impart specific and unusual characters to the scleractinian community. Situated in the SW lagoon of the New Caledonian barrier reef system, the Banc Gail is an example of such uncommon mesophotic environment. There, between 35 and 45m deep, the lagoon floor is subjected to input in the form of periodical pulses of fine terrigenous mud originating from the nearby rivers. The terrigenous silts and clays are trapped in an eddy of the general water circulation and settle on the seabed. Such a turbid environment favours the settlement of oysters forming banks that tends to create ridges up to 3 m high on which corals settle, separated by muddy gullies Although high levels of fine particle sedimentation are proven to be detrimental to the development of scleractinians, a number of corals have adapted to such peculiar conditions, principally low light levels and high rates of fine sediment deposition. The composition of the scleractinian assemblage is examined. Although the suite of species is a subset of the general scleractinian mesophotic fauna, some key components such as the Agariciidae or species of the *Acropora elegans* group are uncommon or absent. Further, most species show unusual growth forms in response to the high and periodic muddy particle ingress and a high incidence of natural fluorescence has also been observed

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JUVENILE HAWKSBILL AND GREEN SEA TURTLE MOVEMENT BETWEEN SEAGRASS BEDS, CORAL REEFS AND ARTIFICIAL REEFS IN BREWERS BAY, US VIRGIN ISLAND (Abstract ID: 29801)

The movement patterns of juvenile sea turtle is one of the largest gaps in our understanding of these endangered/threatened animals. Movement patterns of juvenile

hawksbill Eretmochelys imbricata and green sea turtles Chelonia mydas were analyzed for a period from Aug 1, 2015 to Nov 1, 2015 as part of the UVI's Mare Nostrum project. The project deployed 37 Vemco acoustic receivers in Brewers Bay St Thomas, Virgin Islands. Five hawksbills, 1.4–28.2kg, and five green sea turtles, 9.5-16.4kg, were tagged with external Vemco sonic transmitters. The green sea turtles showed remarkably consistent circadian movement patterns, with days spent in S. filiforme dominated seagrass beds and nights spent in both artificial and coral reefs. The high degree of site fidelity suggests that individuals have specific resting areas where they overnight. All green sea turtles stayed within the approximate 1 km2 area covered by the acoustic array, suggesting home ranges of less than 1 km2. No significant correlation between mass and home range was found in Green sea turtles. Hawksbills showed no obvious circadian movement patterns. Larger Hawksbills had wider movement patterns, suggestive of a correlation between size and home range. Both Hawksbill and Green sea turtles spent more time associated with the artificial reef, extension of St Thomas airport runway, then with natural coral reefs in the Brewers Bay. This data suggest that home ranges of juvenile Hawksbill and Green sea turtles are smaller than that of adult sea turtles reported in the literature.

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FLUCTUATIONS IN ORNAMENTAL FISH POPULATIONS AFTER THE MASSIVE DIE-OFF OF CORAL IN 1997 ON THE PADANG SHELF REEF SYSTEM, INDONESIA (Abstract ID: 29257)

Ornamental fish communities are part of the reef fish community associated with coral reef ecosystems. They are exported from Indonesia for the aquarium trade. Surveys of reef fish has been conducted continuously on the reefs off Padang, West Sumatra, Indonesia before and after the occurrence of massive die off of coral in 1997. Surveys were conducted again in May 2014 to see the change in fish populations at permanent transects at 3 Islands (Pulau Pieh, P. Pisang, P. Pandan) and on 3 patchreefs (Gabuo, Air and Sipakal). This report concentrates on changes in the ornamental fish populations since the die off. The species and number of individuals per species were recorded 2.5 m either side of three 30 m transects at each site. Twenty four families of ornamental fish from the low to the high demand, were recorded which the highest demand including Chaetodontidae, Pomacanthidae, Achanturidae Balistidae Achanturus Leucosternon Pomacentridae and 7 species. The following species were the most abundant: 3,17% of Pomacentrus alleni on the high demand, 58,57% of Odonus niger on the middle demand and 8,42 of Abudefduf vaigiensis on the low demand. The results obtained by the average number of species of fish as much as 41,5 and the average number of population of 682,92 individual fish. The number of species and number of individuals of ornamental fish was higher in 2014 than in 2007 and lower than in 2001. The mass death of corals impacts the number of species and individuals of ornamental fish or reef fish in the waters of the Municipality of Padang and surrounding areas. Keywords: Ornamental fish, reef fish communities, fluctuations, mass death of corals
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LARGE PREDATORY CORAL TROUT SPECIES UNLIKELY TO MEET INCREASING ENERGETIC DEMANDS IN A WARMING OCEAN (Abstract ID: 28362)

Increased ocean temperature due to climate change is raising metabolic demands and energy requirements of marine ectotherms. If productivity of marine systems and fisheries are to persist, individual species must compensate for this demand through increasing energy acquisition or decreasing energy expenditure. Here we reveal that the most important coral reef fishery species in the Indo-west Pacific, the large predatory coral trout *Plectropomus leopardus* (Serranidae), can behaviourally adjust food intake to maintain body-condition under present day (24-30˚C) and elevated (+3˚C) temperatures, and acclimate over time to consume larger meals. However, 3˚C elevated temperatures also caused a 55% reduction in spontaneous swimming speeds and doubled the time individuals spend resting motionless on the bottom. Given that movement and activity patterns of large mobile species are directly related to prey encounter rates and ability to capture prey, any reductions in activity patterns are likely to reduce foraging opportunity and limit the energy available for growth, reproduction and fitness. Additionally, increased energetic demands are unlikely to be met by adequate production at lower trophic levels, as smaller prey species are often the first to decline in response to climate-induced loss of live coral and structural complexity. Consequently, ubiquitous increases in energy demand combined with reduced foraging opportunity due to climate change will increase top-down competition for a dwindling biomass of prey, and potentially distort entire food webs and associated fisheries.

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SAVING THE "CRITTER CAPITAL" THROUGH SUSTAINABLE LIVELIHOOD INITIATIVES (Abstract ID: 29611 | Poster ID: 685)

St. Vincent and the Grenadines(SVG) is promoted to dive enthusiasts as the 'Critter Capital' of the world and is home to the smallest coral reef creatures. Since the lionfish invaded SVG's waters in 2010, fishers and divers noted the negative impact on coral reef fish; a problem that may lead to a critter crisis. SVG is currently establishing a second marine park and the possible disenfranchisement of fishers is of critical concern since the majority of the population depends on the marine environment for their income and diet. In order to address the lionfish invasion and provide fishers with supplementary livelihoods options, a sustainable livelihoods initiative was implemented by the Climate Resilient Eastern Caribbean Marine Managed Areas Network (ECMMAN) project. The project was implemented jointly by two dive shops and two fisher organizations. The project outcomes included the certification of 25 fishers in diving and training in lion fish culling methodologies with permission to catch lionfish within the proposed MMA; the establishment of a tackle shop with lionfish culling equipment; the promotion of lionfish consumption; and stable markets for lionfish sales. The project has recorded many benefits including (i) reduction in lionfish populations, (ii) rebounded populations of reef critters, (iii) establishment of a secure lionfish market through restaurants and hotels, (iv) improved partnerships and communication among dive shops and fisher organizations, and (v) the demonstration of a successful sustainable livelihood initiative in a small island state.

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HIERARCHICAL EFFECTS OF THE ENVIRONMENT ON THE DISTRIBUTION AND SIZE OF PARROTFISH ON THE NORTHERN GREAT BARRIER REEF. (Abstract ID: 30024 | Poster ID: 247)

Scarine labrids (parrotfishes) are critical to the resistance of reefs from shifting to a macroalgal dominated state on reefs worldwide. Despite their importance, few studies have investigated the community structure of parrotfishes on the Great Barrier Reef at large spatial scales. The distribution of 25 parrotfish species was examined at 82 sites on the Northern Great Barrier Reef from north of Cape Tribulation to Cairns, representing spatial scales both cross-shelf and along a 6 degree longitudinal gradient. Parrotfish and predator abundance was recorded using stereovideo cameras to facilitate consistently accurate length measurements for all species encountered. Total predator biomass (kg / Ha) and parrotfish biomass (kg /Ha) were calculated at each site. To investigate their role in parrotfish community structure, coral cover, slope and rugsoty were also quantified at each site. Similarly to previous studies (Hoey & Bellwood 2008), clear patterns emerged in abundance and biomass of parrotfish on a cross-shelf gradient. As distance from shore increased parrotfish densities increased, while total parrotfish biomass increased. Patterns of variation in community structure were difficult to distinguish at a larger 6 degree longitude spatial scale. Despite the increase in biomass of parrotfish from inshore to the outer shelf, the majority of biomass is represented by a smaller diversity of species.

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SUCCESSES, CHALLENGES, AND LESSONS LEARNED FROM A DECADE OF CAPACITY BUILDING FOR IMPROVING THE MANAGEMENT OF MARINE PROTECTED AREAS (Abstract ID: 29753)

With some 9,000 Marine Protected Areas (MPAs) designated globally (Spalding et al, 2013), only a small fraction of these are considered effectively protected. At the same time with the array of capacity development programs offered around the globe, there is now more than ever the need to assess the progress made by marine resource managers in meeting their management objectives; establish and set staff competency standards; and communicate results in terms of the return on these investments. NOAA's International MPA Capacity Building Team strives to improve marine and coastal resource management by bring together different MPA management models from around the world and sharing experiences and lessons learned amongst marine and coastal re-

source managers. After a over a decade of work, we have developed a successful model for improving the capacity of coastal and marine area managers to ensure successful management. As part of this, we recognize a key element in comparing the success of capacity building program is ensuring there's a standardized means for defining what are we trying to achieve as well as outlining common benchmarks for "success". Additionally, we need to consider standardizing indicators of success. A systematized set of standards and indicators for results-based capacity development would provide a means to measure and compare the effectiveness of capacity development efforts across a region and globally in moving towards effective marine and coastal area management.

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CORAL COMMUNITY CHANGE ON A TURBID-ZONE REEF COMPLEX: DEVELOPING BASELINE RECORDS FOR THE CENTRAL GREAT BARRIER REEF'S NEARSHORE CORAL REEFS (Abstract ID: 27950)

Understanding past coral community development and reef growth is crucial for placing contemporary ecological and environmental change within appropriate reef-building timescales. Coral reefs located within coastal inner-shelf zones are widely perceived to be most susceptible to declining water quality due to their proximity to modified river catchments. On the inner-shelf of Australia's Great Barrier Reef (GBR) the impacts and magnitude of declining water quality since European settlement (c. 1850 A.D.) still remain unclear. This relates to ongoing debates concerning the significance of increased sediment yields against the naturally high background sedimentary regimes and the paucity of long-term (>decadal) ecological datasets. To provide baseline records for interpreting coral community change within the turbid inner-shelf waters of the GBR, 21 cores were recovered from five nearshore reefs spanning an evolutionary spectrum of reef development. Discrete intervals pre- and post-dating European settlement, but deposited at equivalent water depths, were identified by radiocarbon dating, enabling the discrimination of extrinsic and intrinsic driven shifts within the coral palaeo-record. We report no discernible evidence of anthropogenically-driven disturbance on the coral community records at these sites. Instead, significant transitions in coral community assemblages relating to water depth and vertical reef accretion were observed. We suggest that these records may be used to contextualise observed contemporary ecological change within similar environments on the GBR.

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VULNERABILITY OF PACIFIC REEF-DEPENDENT COMMUNITIES TO OCEAN ACIDIFICATION: FOOD SECURITY AND LIVELIHOOD IMPLICATIONS (Abstract ID: 28429)

In the Pacific region, coral reefs provide critical goods and services for coastal communities, particularly food security, livelihoods and coastal protection. The implications of ocean acidification (OA) are significant due to the expected impacts of OA on reef structure and fish productivity. Combined, these impacts present a major challenge for reef-dependent communities. Here we present the results of an assessment of vulnerability of reef-dependent communities in 22 Pacific island countries and territories (PICTs) that focused on the projected impacts of OA in 2050 on reefs and their goods and services. In particular, we examined fisheries production for food security, livelihood income, employment and reef area as a proxy for coastal protection. The semi-quantitative assessment used indicators to score and rank communities based on their: (i) exposure to reef habitat degradation, (ii) sensitivity to declines in reef goods and services, and (iii) adaptive capacity as measured by social indicators of health, education, economy size and governance. The PICTs assessed with the highest relative vulnerability were: Solomon Islands, Kiribati, PNG, FSM, Tonga and Tuvalu. The PICTs with the lowest relative vulnerability were: Niue, Northern Mariana Islands, Tokelau, New Caledonia and Guam. Key factors contributing to high vulnerability were large reef to land area ratio, a high percentage of household earnings from coastal fisheries, and education as a driver of low adaptive capacity. In contrast, PICTs with low relative vulnerability consistently had high adaptive capacity and generally low reef to land ratios. These results are informing future adaptation planning.

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CONNECTIVITY AMONG POPULATIONS OF THE INVASIVE LIONFISH (*PTEROIS VOLITANS*) IN THE ATLANTIC, CARIBBEAN AND GULF OF MEXICO. (Abstract ID: 28211)

Lionfish have recently invaded Atlantic waters beginning in the North Atlantic in the late 1980s progressing into the Caribbean in 2006 and into the Gulf of Mexico (GOM) as of 2010. We investigated the population genetic connectivity of the invasion across these three regions. Previous studies found that there are 9 mitochondrial control region (d-loop) haplotypes found in samples from the North Atlantic region (ATL) and that the Caribbean (CAR) region has only a subset of those haplotypes (n = 4). Our samples from the Gulf of Mexico contain only three haplotypes. It is clear from these samples that there were founder effects within each region as they were successively colonized and possible slight barriers to dispersal among the three regions (ATL, CAR, GOM). It is clear from our data that the GOM was colonized by dispersers from the CAR rather than the ATL as there is no evidence of the ATL only haplotypes in the Gulf samples. Understanding the genetic composition and patterns of connectivity of lionfish will help aid in multi-agency management efforts to control lionfish populations and the further spread of lionfish.

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A SUSTAINABLE REPOSITORY FOR CORAL REEF HISTORICAL IMAGERY (Abstract ID: 29369)

Underwater photographs of known reef sites are valuable sources of historical data. As part of a new initiative to create a sustainable, open-access repository of historical reef imagery and associated data, a collection of 1480 images made by Eileen Graham in the mid 1960s near Discovery Bay Jamaica are available for download at http://data.nhm.ac.uk. Images have precise location and date information, and they record the state of reefs prior to their decline in the 1980s and before well-established monitoring surveys in the Caribbean. Images range from detailed close-ups to reefscapes, and are a rich source of ecological data including benthic community composition and habitat complexity. Ecological change on coral reefs shows great variability at local scales, thus we aim to establish a network of image repositories from reefs worldwide to help define local baselines that better inform decision-makers. The time is right because the first generation of SCUBA-enabled scientists are retired and should be considering the future disposition of their photographs. Our experience with assembling this collection indicates that it is critical to work closely with photographers to capture information on dive sites and dates. Furthermore, we would like to highlight the role of natural history museums as sustainable repositories of historical archives. In contrast to short-term projects, museums are better able to guarantee future availability of reef imagery because they have the long-term commitment and resources required for the curation and dissemination of scientific data.

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TURFS OF THE FUTURE: GLOBAL CHANGE IMPACTS ON BIOLOGICAL AND COMMUNITY RESPONSES OF CORAL REEF TURF ALGAE (Abstract ID: 28860)

Coral reef algae are critically important for organic and inorganic production in tropical systems, yet they are markedly understudied in the context of global change. Within the algae, even less is known about the response of turf algae communities to environmental stressors. We conducted a mesocosm experiment in Moorea, French Polynesia to test the combined effects of $CO_2$ enrichment and warming temperatures on turf growth, physiology, community structure and endolithic growth. These metrics relate to the roles of turf algae in production, competition, and as a resource for herbivores. Carbonate plugs covered by turf were collected from the reef and exposed to ambient and elevated $CO_2$ (1,000 µatm) conditions for three weeks. Each $CO_2$ treatment was replicated across six temperatures, ranging from 24-31.5°C. OA and warming had complex, and sometimes interactive, effects on turf algae response. OA stimulated growth of both turf algae and the endolithic community, but more so at warmer temperatures. Conversely, temperature alone stimulated photosynthetic production and respiration. OA and warming also altered community structure, with a shift towards dominance by cyanobacteria in warmer and more acidic conditions. These results indicate that global change impacts could enhance the competitive ability of turf algae over other slower growing taxa such as reef-building corals. The complex and differing effects of $CO_2$ enrichment and warming across a suite of algal responses demonstrate how multiple stressors have diverse and unexpected biological effects.

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TEN YEARS OF LARGE SCALE CORAL BLEACHING MONITORING ACROSS THE FLORIDA REEF TRACT (Abstract ID: 28876)

The Florida Reef Resilience Program (FRRP) is a collaborative effort among managers, scientists, conservation organizations and reef users to develop resilience based management strategies for coping with climate change and other stresses on Florida's coral reefs. Since 2005, The Nature Conservancy has coordinated a Disturbance Response Monitoring (DRM) effort, consisting of a probabilistic sampling design and a stony coral condition monitoring protocol, implemented during peak thermal stress across the entire Florida Reef Tract that extends from Martin County to the Dry Tortugas. Each year, 13 teams from federal, state, and local government agencies, non-profit organizations, and universities completed surveys across the entire South Florida reef tract within a six to eight week period. Sites were stratified randomly, allowing information gathered on the coral population's size frequency, size structure, and bleaching prevalence to be extrapolated for different sub-regions and zones. From 2005 to 2015, 2,200 surveys were completed. Results from these ten years of surveys show spatial and temporal patterns in coral bleaching and colony size frequency distribution, indicating that some reef areas or coral species may be more resilient to stress than others. While the causes of this variability remain poorly quantified, projected increases in coral bleaching due to climate change makes identification of these resilient reef areas and species important for long-term coral reef conservation and future management strategies.

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3D PHOTOGRAMMETRY FOR MEASURING REEF PRODUCTIVITY: ADVANCES IN LIGHT PROPAGATION AND SELF-OCCLUSION (Abstract ID: 28381)

With recent advances in photographic 3D benthic mapping, it is now possible to build high-resolution 3D maps of benthic ecosystems over large spatial areas that will allow us to address the importance of 3D reef structure for community metabolism. Using stereoscopic photogrammetry and scene reconstruction, the distribution and approximate surface areas of most stationary members of the community can be obtained. As light is the major short-term control on reef productivity, we propose to generate a model of received light over the surface of the reconstructed community. The key technical advance proposed here in underwater 3D reconstruction is the use of multi-view stereo to improve both the spatial density and accuracy of the 3D structure of the structural models, building on previously developed 2-view methods. This multi-view formulation, in conjunction with more sophisticated models for light propagation through water, will enable us to both measure light in its capacity as a driver for reef metabolism and generate more accurate 3D models of the reefs for all manner of study. Results will be displayed on real data gathered from a mixed coral-algal reef in the Florida Keys.

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ROOTING THE TREE; PHYLOGENOMIC ANALYSIS OF POCILLOPORA CORALS PROVIDES EVOLUTIONARY INSIGHTS INTO RECENT DIVERSIFICATION. (Abstract ID: 28840)

Pocillopora corals are notoriously difficult to identify and recent work has found more cryptic species and plasticity than preciously thought, motivating a reorganization of the genus. Here, we analyze the phylogenetic relationships within the scleractinian genus Pocillopora using RAD-seq. We examined 15 coral holobiont libraries and found strong concordance in both the phylogenetic analyses of the entire holobiont dataset and reads that mapped to transcribed coral genes. We further assembled nearly complete mitochondrial genomes (18 kb), a 5 kb segment of histone gene sequence, and 430 unlinked, biallelic SNPs, which also show general concordance with previously published clustering of the mitochondrial clades rather than the currently recognized morphospecies. This analysis expands on previous genetic, morphologic, and ecological studies and corroborates that Pocillopora have more variable and convergent morphology than previously appreciated. Our data provide unprecedented phylogenetic resolution into the recent radiation of species within this genus, with general concordance between mitochondrial and nuclear datasets indicating that there is not rampant hybridization or introgression between mitochondrial lineages.

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VALIDATION OF REEF-SCALE THERMAL STRESS SATELLITE PRODUCTS FOR CORAL BLEACHING MONITORING (Abstract ID: 28114)

Satellite monitoring of thermal stress on coral reefs has become an essential component of reef management practice around the world. A recent development by the U.S. National Oceanic and Atmospheric Administration's Coral Reef Watch (NOAA CRW) program provides daily global monitoring at 5 km resolution—at or near the scale of most coral reefs. This and other novel CRW products may provide crucial information in support of local monitoring and management activities prior to, during, and after thermal stress events. Using in situ survey data collected during the 2014 thermal stress event across the Northern Mariana Islands, we undertook the first quantitative comparison between 5 km satellite monitoring products and coral bleaching observations. Observed bleaching at 62 sites across seven islands ranged from 0%–94% of live coral cover. Analysis of coral community characteristics, historical temperature conditions, and current thermal stress revealed a strong influence of coral biodiversity on the patterns of observed bleaching. This resulted in a model based on thermal stress and generic richness that explained 97% of the variance in bleaching. These findings illustrate the importance of using local benthic community characteristics to predict and interpret the level of impact from thermal stress exposure. In an era of continuing climate change, accurate monitoring of thermal stress and prediction of coral bleaching and resilience are essential for managers to utilize resources effectively and conserve coral reefs.

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LONG-TERM MONITORING OF CORAL ASSEMBLAGES IN FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY, GULF OF MEXICO (Abstract ID: 28368 | Poster ID: 13)

The Flower Garden Banks National Marine Sanctuary, consisting of East Flower Garden Bank (EFGB), West Flower Garden Bank (WFGB), and Stetson Bank, contains coral reefs and coral communities in the northwestern Gulf of Mexico. Long-term monitoring programs have been conducted at EFGB and WFGB since 1989 and at Stetson Bank since 1993. We examined 27 years of shallow (<33.5 m) benthic percent cover data at EFGB and WFGB, providing a long-term trend analysis of the community structure. Although percent macroalgae cover has increased significantly, mean coral cover averaged above 50%. In contrast to many other phase shifting reefs in the Caribbean region, the increase in macroalgae cover has not resulted in coral decline at EFGB and WFGB. Conversely, benthic monitoring at Stetson Bank has documented three community shifts (2000, 2006, and 2015). In this 23 year time frame, both sponge and coral cover declined, macroalgae cover varied widely, and the reef has been impacted by bleaching, hurricane damage, and land-based runoff. The highly variable environmental conditions at Stetson Bank differ drastically in comparison to the relatively stable conditions at EFGB and WFGB. This is largely due to Stetson's more northern latitude and closer proximity to shore. Continued long-term monitoring documents changes in the reef communities at the marine sanctuary, enabling resource managers to make decisions regarding management and research activities focused on the dynamics of the benthic communities and the megafauna they support.

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GENETIC AND BIOPHYSICAL MODELING ASSESSMENT OF CONNECTIVITY IN THE RED GROUPER, EPINEPHELUS MORIO (Abstract ID: 29516)

Understanding connectivity of reef organisms is important to aid the conservation of biological diversity and facilitate sustainable fisheries. Common methods to assess reef connectivity include genetics, modeling, and tagging. Individually, these techniques can offer insight into population structure; however, the information acquired by a singular analysis is often subject to inherent limitations of the chosen method. Thus combining approaches may allow for better resolution of population structure and the biophysical factors driving it. We utilized both genetic analysis and biophysical modeling to assess connectivity dynamics and linkages of the red grouper (Epinephelus morio), a major reef fishery species found throughout the Gulf of Mexico (GOM) and southeastern USA (SE-USA). First, we used a model to incorporate ocean conditions and biotic traits of the grouper to deliver a spatial forecast of 'source' and 'sink' populations in the GOM and SE-USA spanning ten years. Next, using a suite of 13 polymorphic microsatellite markers we assessed the genetic population structure of red grouper across this same spatial scale to directly compare levels of connectivity between methods. Our population genetic survey of groupers suggested high connectivity and the presence of a single genetic population. Similarly, modelling the fish over ten years suggested panmixia over generations. Using a dual empirical and theoretical approach lessens error over one method alone and is important validation of both the genetic and biophysical modeling techniques used in this study.

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KANEOHE BAY, OAHU, HAWAII: CENTURIES OF HUMAN IMPACT AND REEF RECOVERY WITH PROJECTIONS TO 2050 (Abstract ID: 27908)

Kaneohe Bay has endured a long history of anthropogenic disturbance and recovery. The bay is currently experiencing increasing episodes of coral bleaching due to global warming. The long-term outcome is in doubt, so a review of past reef resilience can be informative. The first contact by Polynesians occurred over 1500 years ago. Expanding population led to exploitation of marine resources, clearing of land for agriculture, introduction of alien species, construction of massive shoreline fish pond enclosures and extensive terraces in the valleys that were used for taro culture. The arrival by the first Europeans in 1778 led to development of a plantation agricultural system accompanied by increased human immigration, population growth and an end to traditional management practices. During 1930-1940 the reefs were devastated by extensive dredge and fill operations. Human population increases led to extensive urbanization of the watershed. By the 1960's the bay was severely impacted by sewage discharge along with increased sedimentation due to improper grading practices and stream diversion-channelization that led to extensive loss of coral cover. Management action corrected many of these problems and the reefs recovered. Increasing global temperature is now impacting these reefs with the first "bleaching event" in 1996 and more severe events in 2014 and 2015. The reefs of Kaneohe Bay developed and have persisted under severe natural and anthropogenic perturbations. To date, these reefs have proved to be very resilient, but a major question remains as to their limits in the face of future global climate change.

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COMMUNITY PARTICIPATION IN MARINE RESOURCES MANAGEMENT: A CASE STUDY OF THE PROPOSED TUN MUSTAPHA PARK, SABAH (Abstract ID: 29161)

In March 2003, the Government of Sabah approved the intention to gazette the proposed Tun Mustapha Park (TMP), an almost one million hectares marine area located at the northern part of Sabah. Located within the Coral Triangle, TMP harbors one of the richest marine flora and fauna complexes in the world and is also home to more than 80,000 coastal dwellers that depend on a healthy continuous supply of marine resources. TMP will be the largest marine protected area in Malaysia once it is formally gazetted. Because of its size and the commercial activities that occur in the region, it requires a multidisciplinary and collaborative management system. Increasingly, community support and participation in the establishment of a Marine Protected Area (MPA) is seen very important to ensure the success of the MPA. However, little attention has been given to how communities respond to MPA, particularly how they can actively participate in the management of their marine resources, following the establishment of a restrictive collaborative management regime. In this paper, we explore the early effects of a MPA geared towards the management of marine resources as well as possibilities of combining Ecosystem Approach to Fisheries Management to communities current fisheries management practice. To illustrate our case, we draw upon our research experience in social, fisheries and biological assessment and our experience in establishing marine protection in the TMP. Keywords: Marine Protected Area, Ecosystem Approach to Fisheries Management, Community based Marine Resources Management

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DEGRADATION OF INDONESIAN CORAL REEFS: SCIENTIFIC AND MANAGEMENT CHALLENGES AND SOME SOLUTIONS… (Abstract ID: 29973)

Coral reefs of Indonesia, at the center of Coral Triangle biodiversity hotspot, have suffered from long term pressures, including destructive fishing practices, overfishing, coral mining, sedimentation, pollution, eutrophication, anchoring, and recently from coral diseases and global warming. Global warming has caused serious coral mortality due to mass bleaching around the globe in the last decades. Emerging diseases and more frequent outbreaks of coral predators such as Crown of Thorn star fish have also occurred in many reefs. Due to long-term destruction and decreased population of herbivores and increase of nutrient inputs, many reefs have experienced phase shift from coral to rubble, sand, or algal dominated reefs. Combinations of these factors have contributed to coral reef degradation in Indonesia, where only around 6% of coral reefs remain in very good condition. Science based adaptive and effective management strategies have to find the delicate balance among and between the people and the reefs to create more resilient and productive coral reef ecosystems. Contemporary strategies include: introducing Marine Protected Area Networks, ecosystem approach for reef management, community based and co-management, strong and effective regulations and proactive coral restoration. Can all of these solve the increasing and alarming pressures on the reefs, with potential benefits to people and ecosystems? We illustrate some of these challenges, and the potential solutions, with examples from around Indonesia, especially Sulawesi and the Birds-Head Seascape.

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ENHANCING MULTI-STAKEHOLDER FISHERIES MANAGEMENT IN POHNPEI, FSM (Abstract ID: 30131)

Over the last two years, the Conservation Society of Pohnpei embarked on a comprehensive coral reef fisheries program to reverse the decline of food fish populations and to establish sustainable management efforts. The program focuses on the integration of strong partnerships, biophysical and socio-economic research, new management interventions, good governance, and behavior change strategies to promote the long-term viability of fish harvesting, compliance, and retail practices among the stakeholders. Fish life history, standing stock, harvest, and market data from research provided information for managers, resource users, and the general public to understand the status and trends of highly targeted species – much of which indicated harvest levels beyond biological capacity, spawning declines, and undermining commercial marketing. To address these concerns, a multi-sectorial Fisheries Support Group helped to identify threats and opportunities for sustainability, introduced new policy, assisted with strategies to enhance compliance and fish retail. Additionally, a Marine Advisory Council provided recommendations to traditional and community leaders on community engagement and culturally appropriate management innovations. As a result of the increased public awareness state, municipal, and traditional and religious leaders have taken concrete steps to strengthen fisheries management. Specifically a number of new regulations and co-management approaches have been adopted including size-based regulations for key herbivores, along with enhanced multi-agency cooperation.
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THE REEF SULPHUR CYCLE: INFLUENCE ON CLIMATE AND ECOSYSTEM SERIVICES (Abstract ID: 27784)

Research in the western Pacific over the last fifteen years has shown that hard corals contain exceptionally high concentrations of a sulphur substance called dimethylsulphoniopropionate or DMSP which can produce a volatile sulphur substance called

dimethylsulphide or DMS. Of all the different coral species, staghorn coral or Acropora species produce the greatest amounts of atmospheric DMS. Oxidation of atmospheric DMS produces a sulphate aerosol which can potentially form cloud condensation nuclei leading to low level cloud development. An increasing amount of evidence now suggests that DMS emitted from coral reefs could keep sea surface temperatures (SSTs) cooler in the western Pacific, including the Great Barrier Reef, through this reef produced low level cloud climate feedback. However, recent research on the effect of coral bleaching on this climate feedback indicates that enhanced solar radiation could reflect increased DMS emissions from reefs increasing SSTs and causing this feedback to shut down, exacerbating the bleaching response. The production of these natural sulphur substances from coral reefs; their effect on regional climate, bird, bacterial and fish behaviour, and possible use as Polynesian navigational aids are reviewed, providing evidence of a very valuable and important ecosystem service not previously described. Research on the effect of coral bleaching on this coral reef climate feedback indicates that increasing SSTs cause this feedback to shut down, exacerbating the bleaching response.

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EXAMINING RECOVERY RATES AMONG FISHES INSIDE A NO-TAKE MPA IN BELIZE. (Abstract ID: 29772 | Poster ID: 643)

As pressures mount to protect the economic and ecological benefits of its coral reefs and associated fisheries, the Caribbean nation of Belize has increased the area of its territorial sea under no-take protection as well as issued nation-wide harvest bans on herbivorous fishes. In 2011, we set up a long term monitoring program at the onset of the newly enforced no-take area within the South Water Caye Marine Reserve (SWCMR), with 12 permanent transects inside the reserve boundary and 12 outside. An aggressive protocol assesses hard corals and fishes for abundance, diversity, size distribution and condition while generating benthic composition photoquadrats. After five years of bi-annual surveys, we found that coral cover and community composition differ between habitats, but are similar inside and outside the no-take area. The abundances of several fish species, however, are significantly higher inside the no-take area, a pattern that presumably existed prior to no-take enforcement. After five years of monitoring, we expect that fish species with nation-wide harvest bans (scarids and acanthurids) should show no difference in abundance or biomass inside the SWCMR when compared to outside the reserve. However, for long-lived species of commercial interest, trajectories of abundance or biomass should differ inside the no-take area.
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LANDSCAPE PATTERNS OF SYMBIODINIUM COMMUNITY DYNAMICS IN ORBICELLA FAVEOLATA DURING AND AFTER THE CONSECUTIVE MASS BLEACHING EVENTS OF 2014 AND 2015 (Abstract ID: 29588)

Despite the high level of concern regarding coral bleaching, and the expectation that bleaching events will increase in both severity and frequency, little is known about how *Symbiodinium* dynamics correlate with landscape patterns of bleaching and recovery. To this end, we tagged 150 colonies of *Orbicella faveolata* at six separate sites at Cheeca Rocks, an inshore patch reef in the upper Florida Keys, and took tissue samples from the same colonies during: 1) peak bleaching in 2014, 2) recovery in early 2015, and 3) recovery from the 2015 mass bleaching in early 2016. Landscape patterns of bleaching and recovery were investigated by taking > 2000 high resolution photographs from 1-2 m above the seabed at each of the same six sites before, during and after the two bleaching events. The photos were then stitched together to generate a composite mosaic image approximately 10m by 10m. Tissue samples were analyzed using quantitative-PCR to determine the relative abundance of *Symbiodinium* from clades A-D in each of the corals. Plots (pie charts and bar graphs) depicting symbiont community structure in each of the tagged colonies were layered over the landscape mosaics using ArcGIS to assess linkages between symbiont types, mortality (partial and full), and recovery. These data will provide insight into landscape patterns of bleaching and recovery, providing managers with information about bleaching patterns at the reef-scale and the role that *Symbiodinium* play in these trends.

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MANGING DREDGING NEAR CORAL REEFS (Abstract ID: 28779)

Maintenance and capital dredging represents a potential risk to tropical environments, especially in turbidity-sensitive environments such as coral reefs. There is a need to develop water quality thresholds for dredging near coral reefs that can relate physical pressures to biological responses and define exposure conditions above which effects could occur. These thresholds can then be used for day-to-day management purposes. Water quality characteristics during dredging have, however, not been well described and this information is needed to test realistic exposure scenarios, to better understand the seawater-quality implications of dredging, and ultimately to better predict and manage impacts of future projects. Using water quality information from three recent major capital dredging programs in North Western Australia, we describe sediment particle sizes in the water column and seabed, suspended sediment concentrations at different temporal and spatial scales during natural and dredging-related turbidity events, and changes in light quantity/quality underneath plumes. These conditions differ considerably from those used in past laboratory studies of the effects of sediments on corals. Other problems associated with using information from past studies for developing thresholds include the existence of multiple different and inter-connected cause-effect pathways (which can confuse/confound interpretations), the use of sediment proxies, and the reliance on information from sediment traps to justify exposure regimes in sedimentation experiments.

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TRANSBOUNDARY CORAL REEF MONITORING FOR THE GRENADINES NETWORK OF MARINE PROTECTED AREAS (Abstract ID: 28356)

The establishment of GNMPA was led by local transboundary NGO the Sustainable Grenadines Inc SusGren. In 2011, SusGren established the GNMPA in order to strengthen MPA management on the Grenada Bank. At a meeting in June 2014, the GNMPA set short-term goals to train at least one staff member from each of the six participating MPAs in coral reef monitoring, and to establish one long-term coral reef monitoring site in each of the MPAs in the coming year (2014-2015). The Network selected the Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocol for reef ecosystem monitoring. Small grants under a U.S. National Fish and Wildlife Foundation project were used to sponsor an AGRRA coral reef monitoring training workshop and the first Grenadines-wide field work expedition by and for members of the Grenadines Network of Marine Protected Areas. We will present findings about the condition of coral reefs across two countries and six biologically-connected MPAs and highlight lessons learned for MPA management in this and other locations in the Caribbean. All except for one site exhibited high coral cover and low fleshy macro algal cover relative to the Caribbean regional averages reported by AGRRA. Several MPAs have the potential to tip the balance back towards coral dominated reefs if herbivores are brought back (eg. by protecting parrot and other fish). Fish biomass, particularly of commercially important species such as groupers and snappers, was found to be significantly lower in the Grenadines MPAs than Caribbean regional averages, indicating strategic directions for education and outreach, enforcement and ongoing monitoring.

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INTEGRATED INSTRUMENTATION FOR MARINE ENVIRONMENTAL MONITORING (Abstract ID: 30127)

Persistent environmental monitoring can offer unparalleled information about marine ecosystems but presents several challenges for instrumentation and data processing. Here we describe two novel systems to enhance capabilities and reduce costs for environmental monitoring: 1) an Intelligent Adaptable Monitoring Package (iAMP) that integrates a flexible suite of instrumentation into a single, streamlined body and 2) the infrastructure allowing an inspection class ROV and custom tool skid to deploy the iAMP to a cabled docking station. The monitoring capabilities supported by the iAMP can provide real-time visual and acoustic data of the surrounding marine environment for multi-month deployments. Instrumentation supported by the iAMP prototype includes a hybrid stereo-optical and acoustical camera system, a multi-beam sonar, a localizing hydrophone array, fish tag receiver, and an acoustic Doppler wave and current profiler. The adaptable design of this platform allows researchers to customize the instrument

configuration to address evolving research goals. The iAMP software integrates the data streams from all instruments to achieve situational awareness through sensor fusion. This allows the iAMP to continuously monitor all sensors, but only archive events of significance for post-processing. Integration also minimizes interference between active acoustic instruments. While motivated by marine energy applications, the iAMP can provide researchers with new information about a range of marine ecosystems.

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## DISENTANGLING THE ROLE OF HUMAN AND NATURAL DRIVERS OF MULTIPLE REEF REGIMES ACROSS THE HAWAIIAN ARCHIPELAGO (Abstract ID: 29800)

In the face of global change and increasing anthropogenic impacts, there is an urgent need to understand the human and natural drivers that support or undermine different reef regimes. A key challenge for coral reef management is to understand how these different drivers combine and interact to affect coral reef systems. Here, we use one of the most extensive natural and human driver dataset ever put together for the main Hawaiian Islands, in conjunction with the recent identification and mapping of five distinct ecological reef regimes occurring across the archipelago. We draw on a combination of machine learning methods to identify non-linear relationships, quantify the thresholds, and characterize the interaction patterns that explain the occurrence of the different regimes. The study provides novel insights into the multi-scale dynamics of Hawaiian reef regimes and allows a comprehensive assessment of what drives them. Results should aid practitioners and managers to move towards practical implementation of ecosystem-based management by helping them understand the combined influence of key anthropogenic (fishing pressure, sedimentation, effluent, habitat modification, invasive species) and oceanographic (wave energy, chlorophyll-a, irradiance, temperature) drivers.

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## REMOTELY PILOTED AIRCRAFT SYSTEMS: BRIDGING THE SCALE GAP BETWEEN FIELDWORK AND REMOTE SENSING FOR CORAL REEF MONITORING (Abstract ID: 28105)

Remote sensing plays a critical role in understanding reef spatial patterns related to habitat distribution, productivity, geomorphic zonation, bathymetry, water quality, and water temperature at scales of square meters to square kilometers. Yet while satellites provide large area coverage at moderate to high spatial resolutions, there is a considerable scale gap between space-based and in-situ ground-based observations. Manned aircraft can be used as suitable intermediaries, but are expensive. Enter remotely piloted aircraft systems (RPAS, or drones). Recent technological advances have allowed RPAS to progress from initially providing highly detailed pictures, to producing highly detailed maps. Quality sensor miniaturisation also means that RPAS are becoming increasingly capable of carrying thermal and even hyperspectral sensors, providing a complete image acquisition package. Here we detail the development two systems providing niche capabilities with pilot study data presented from Heron and Orpheus Reefs, Great Barrier Reef. Using a combination of off-the-shelf (3DR Solo + FLIR Vue Pro + Go Pro), and research systems (Aeronavics Icon + Headwall NanoHyperspec + FLIR A65 + Sony a7R), we'll present both thermal and optical data used to assess water temperature variability, as well as benthos type at temporal and spatial scales not previously possible. We document the accuracy and benefits of the systems and their resultant data, and also assess the practical, logistical, and administrative challenges associated with developing the capability for coral reef monitoring.
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## NON-DESTRUCTIVE METHOD FOR COLLECTING INVERTEBRATE SPECIMENS INHABITING CORAL COMMUNITIES USING IMPROVED LIGHT TRAP (Abstract ID: 29118 | Poster ID: 297)

Coral communities providing various micro-habitats and food source for many parasitic or symbiotic invertebrates showed higher biodiversity index and have been known as one of the most important habitats than others communities. However, many coral species are in need of effort for the global conservation and registered in the Red List of IUCN (International Union for Conservation of Nature and Natural Resources). For the preparing efficient management method for conservation of coral communities, it is necessary to generalize overall information about the other parasitic or symbiotic invertebrates including present condition of distribution and interaction between them, but many existing methods of taxonomical and ecological researches have been induced disruptions of coral community habitats. In this study, we improve the existing trap using light source for the development collecting methods of various invertebrate specimens without destruction or disturbance in coral communities. The example researches have been performed from soft coral communities in Jeju Is, South Korea, and can be secure various small crustaceans, as a result. Considering only amphipods, 46 species assigned from 41 genera of 30 families are identified, and 13 gammaridean and 10 hyperiid species can be candidated in new to Korea or new to science among them. Therefore, it is useful tool to acquire various invertebrate specimens inhabiting coral communities without damages to habitats and specimens itself.

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## HOW TO HAVE YOUR FISH AND EAT THEM TOO: MANAGING PERIODICALLY HARVESTED CLOSURES FOR LONG-TERM SUSTAINABILITY (Abstract ID: 27899)

Periodically harvested closures (PHCs) are small fisheries closures that vary in temporal duration and harvest regime and are the most common management strategy in locally-managed marine areas throughout the Pacific. The main motivations for employing PHCs are to sustain fisheries and increase catch efficiency, which presents a tradeoff. We present an analytical framework that informed our research to assess whether PHCs can effectively achieve multiple objectives. We found on average that pre-harvest protection benefits were greater with: high compliance; bigger, older closures; and high fishing pressure outside of PHCs. Reduced wariness in targeted fish was more likely to be observed before increases in abundance or biomass, though harvest events resulted in a rapid increase in fish wariness. Our theoretical model suggests that when fish behavior is considered, PHCs can be a more efficient strategy for achieving multiple objectives than permanent no-take areas or non-spatial management. A literature review revealed that there were insufficient data to evaluate more complex questions of recovery potential and whether PHCs can maintain absolute yields. Empirical data from Fiji one year after harvests show PHCs did not recover to pre-harvest levels or provide post-harvest recovery benefits for targeted fish. Questions regarding long-term sustainability of PHC practice are being addressed using simulated fisheries models calibrated with empirical data to provide guidance on what harvest regimes and relative sizes of PHCs are most effective for achieving multiple objectives.

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SEASONAL VARIATION IN CORAL THERMAL PERFORMANCE ON THE GREAT BARRIER REEF (Abstract ID: 28957)

Thermal performance curves (TPCs) describe the relation between temperature and the rate of physiological processes, such as growth and photosynthesis. These relationships are species-specific and depend on environmental conditions. Previous studies have shown seasonal variation in coral bleaching thresholds, but it is unknown if this is driven by a change in the shape of the TPC. This study aimed to quantify differences in TPCs between winter and summer for a bleaching tolerant coral species, Porites cylindrica, and a bleaching sensitive coral species, Acropora valenciennesi, from the Great Barrier Reef. Photosynthesis rates, respiration rates and photosynthetic efficiency (Fv/Fm) were measured in winter and summer on coral fragments exposed to an acute temperature increase and decrease up to 5 degrees C above and below the average seawater temperature (24 degrees C in winter and 29 degrees C in summer). In winter, photosynthesis rates were highest around 24 degrees C, suggesting physiological acclimation that maximises performance at the average temperature of the environment. However, respiration rates and Fv/Fm were linearly related to temperature suggesting that thermal acclimation does not occur. TPCs measured in summer will be compared with those measured in winter to assess the magnitude of seasonal acclimation and whether the capacity for acclimation differs between species. Quantification of TPCs will improve our ability to project responses of coral populations to climate change by identifying the physiological processes that underlie thermal acclimation.

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THE HERITIBILITY OF CORAL TOLERANCES TO OCEAN ACIDIFICATION (Abstract ID: 29299 | Poster ID: 41)

The release of carbon dioxide due to human activities is leading to ocean acidification, which is expected to reduce coral growth rates, but the magnitude of such responses vary from study to study. Corals upregulate pH at their site of calcification, and some of the variation reported for coral responses to reduced pH may be the result of differing capacity to regulate internal chemistry. Heritable variation underlies the potential for evolution over time, but the degree of variation in pH tolerances among corals, as well as the heritability of any such variation, is unknown. Here we examine the heritable variation among eight of the dominant, Hawaiian coral species to ocean acidification (n = 15 colonies per species). Coral colonies were sampled across natural gradients in seawater chemistry from a total of six different locations around O'ahu, Hawai'i. Corals were allowed to acclimate in a common garden for at least 2 months, and then assessed for their sensitivity to reduced pH in an aquarium experiment.

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LOCAL ADAPTATION DRIVES CORAL RESILIENCE TO OCEAN ACIDIFICATION AND CLIMATE CHANGE (Abstract ID: 29277)

Mass coral bleaching events are expected to become more common as the climate warms, but the long-term trajectories of bleached and non-bleached corals may be impacted by ocean acidification. In response to a mass bleaching event during September 2014 in Hawai'i, bleached and non-bleached colonies of the corals Montipora capitata and Porites compressa were sampled from a low-pH, high-temperature environment in Kane'ohe Bay, and from a nearby, normal-pH, normal-temperature environment off Waimanalo. To examine the effects of ocean acidification on bleaching recovery, corals were exposed to two levels of pH in an aquarium experiment for 12 months using flow-through, Kane'ohe Bay seawater, and the parent colonies sampled in Kane'ohe Bay were tagged and monitored for recovery under natural, field conditions (n = 6 colonies for each set of conditions). A second mass bleaching event occurred in September 2015, allowing us to examine the influences of both fixed and plastic responses by corals to repeated temperature stress. Corals from the low-pH, high-temperature site, Kane'ohe Bay, showed higher tolerances to low pH and elevated temperature as compared to those from Waimanalo. Likewise, bleaching responses were consistent across years among coral colonies from Kane'ohe Bay, both in the field and in the aquariums. Together these results show that pH and temperature tolerances in these two coral species depend strongly on fixed, heritable traits, and suggest that reef-scale resilience to global change can be driven by rapid, local adaptation among corals.

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BUILDING LOCAL CAPACITY BY INCORPORATING REEF CHECK AMERICAN SAMOA INTO ELEMENTARY SCHOOLS IN THE TERRITORY. (Abstract ID: 29741 | Poster ID: 560)

Our reefs provide a home to a vast assortment of marine life while also supporting a diverse array of consumptive and non-consumptive human uses. Village communities in American Samoa have for many years managed their reef areas and enforced their village rules and regulations. As a tradition, villagers have practiced their traditional fishing methods when utilizing their reef areas. These safe and effective traditional fishing practices were often used and the results were plenty of fish and shellfish caught for family consumption. As the years passed by, the American Samoa has gone through major changes over the century, as change is inevitable. These changes include new and advanced fishing methods, rapid growth of population, coastal development, pollution and overfishing. As a result, increasing demands on have been placed on our near shore resources that have altered the approaches and perceptions of the local people on using marine resources to earn more and live better. This project aims to empower youth to appreciate coral reefs and the marine organisms it supports. Incorporating Reef Check American Samoa (RCAS) into the Department of Education helped to achieve some of the objectives stated in the standards and benchmarks for marine science classes. RCAS helped to teach students in their early age about the importance of coral reefs, different roles played by different organisms in the reef and carried out simple scientific survey methods on selected reef fishes, invertebrates and substrates. Students also looked into some of the human activities that are currently affecting local reefs and participated in hands-on activities in order to help the community, collecting trash to prevent it from polluting the water and speaking on the radio about what needs to be done by the community to help save their coral reefs. RCAS aided in the perception of ownership of reefs, help intensify local management capacity within the communities, and provide a broade

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'UKU 'AKO'AKO'A: KIN RELATIONSHIP BETWEEN THE CORAL AND PEOPLE IN NATIVE HAWAIIAN EPISTEMOLOGY (Abstract ID: 28875)

As the indigenous people of an island chain surrounded by coral reefs in the center of the Pacific Ocean, Native Hawaiians have profound ancestral and spiritual connections to the coral. Oli (chants), hula (dances), mele (poetry), and mo'olelo (mythology) of Hawai'i are vessels of scientific knowledge acquired through observations and test of time over generations. Many of these forms of knowledge speak to the kin relationship between the coral, among other organisms, and people. For example, the Kumulipo, a chant that traced the genealogy of the chief Lonoikamakahiki to the environmental deities, describe the coral as the first-born organism in the Hawaiian universe. Another chant 'Uku 'Ākoʻakoʻa further expands this ancestral presence of coral to growth of coral reefs as metaphors of personal growth. A hula, I Kanaloa 'o Kanaloa, speak of primordial presence of the ocean in Hawaiian people's psyche that is embodied by the coral. The four cohorts of students of a class called "Kū'ula: Integrated Science" at the University of Hawai'i at Hilo have developed ways to integrate Native Hawaiian and Western sciences to understand the environment of Hawai'i to manage it in ways that integrate natural and human dimensions. We will present a Native Hawaiian understanding of the intersection of natural and human dimensions pertaining to the coral in the hula and chant formats.

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TAGGING BONEFISH IN HAWAII: EMPOWERING ANGLERS IN SCIENCE (Abstract ID: 29269)

'Ō'io (bonefish) were important to early Hawaiian culture and are one of the most highly sought after recreational fisheries species in modern day Hawaii. Two species of 'ō'io inhabit Hawaiian waters and are targeted by a mix of commercial and recreational fisheries. The 'Ō'io Tagging Project arose from a consensus that collecting biological and fisheries data on 'ō'io is essential to properly manage this resource, while engaging resource users and disseminating this knowledge back to them is equally as important for long-term sustainability of these fisheries. Outreach events allow for interaction with anglers and the project's mission is manifest through magazine articles, social media, scientific publications, and an interactive website. Since 2003, more than 870 anglers have recorded over 11,000 fishing hours, while tagging 3,500 and recapturing 85 'ō'io. Tagged

ʻōʻio exhibited extremely high site fidelity, with 80% recaptured less than 1 km from their original tagging location. Angler participation and collaboration has extended the project to provide the opportunity to study diet, age, growth, and reproduction. This project serves as an excellent vehicle to include resource users in collecting species-specific life history information and fisheries data that can be used in population assessments and management decisions.

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HIGH-ENERGY WINDOW IN MODERN REEFS: AN EXAMPLE FROM MULTI-BEAM BATHYMETRIC MAPPING OF REEF GEOMORPHOLOGY AROUND THE RYUKYU ISLANDS (Abstract ID: 28111)

Accurate descriptions of coral reef geomorphology improve our understanding of reef environments. Since 2010 we have been conducting high-resolution multibeam bathymetric surveys around the Ryukyu Islands, southern Japan, and mapping the coral reef geomorphology with a horizontal grid size of 1–2 m. Here, we introduce our mapping project, which covers of a total of 39 surveyed areas across five islands, and present an example illustrating the barrier reef and island shelf geomorphology of eastern Kume Island (1.8 × 6.5 km bathymetric area, with a depth range of 0.4–161.3 m) combined with SCUBA and VTR observations. The bathymetric area comprises two contrasting reef edge formations: a double reef in the western area, and a deep breakwater reef in the eastern area. The latter shows the high-energy window condition which is accompanied by spur and groove formation in the lagoon, formation of circular spits or bowl-shaped depressions behind the lagoon patch reefs, and traces of movement of coral boulders in the lagoon following typhoon storm surges. These observations enable us to understand and reconstruct the paleo-geomorphology and sedimentology in reefs associated with the Holocene high-energy window, and can also contribute to predictions of coastal environmental change associated with future sea level rise. On the island shelf, we observed five reef terraces at depths between 80 and 95 m, and isolated patch reefs at 135 m depth. The discovery of these features may contribute to reconstructions of past sea level and reef growth in the northwestern Pacific.

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CORALSPEQ AND PHOTOSYNQ: AN OPEN, FIELD-DISTRIBUTABLE PLATFORM FOR PROBING CORAL HEALTH ON LOCAL AND GLOBAL SCALES (Abstract ID: 29910)

We have developed an inexpensive but sophisticated field-portable instrument, called CoralspeQ, that dramatically lowers the entry barriers making detailed phenotypic measurements of coral host and its symbiotic algae (as well as other marine photosynthetic organisms) to enable researchers, park rangers and citizen scientists all over the world to probe coral health and the factors that may affect bleaching. CoralspeQ measures spectroscopic properties (both reflectance and fluorescence) under a range of excitation conditions to estimate pigment composition and photosynthetic properties. CoralspeQ is open-source, highly affordable, easy to use and highly expandable. Data from field sites are instantly uploaded to PhotosynQ for both local and global data analyses to reveal new trends that can be used to assess the progress of coral bleaching, test mechanistic hypotheses, and ultimately lead to new coral conservation approaches. Tests in the field and laboratory showed that we could use the signals generated by CoralspeQ to distinguish between "stressed" and healthy corals (See presentation by Ralph et al.). This presentation will describe demonstrations, opportunities to test the platform live and discuss how researchers can gain access to both CoralspeQ and PhotosynQ.

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SPONGES AS A MICROHABITAT FOR MACROFAUNA AND MICROBES ACROSS ECOLOGICAL GRADIENTS IN THE CENTRAL RED SEA (Abstract ID: 29140)

Sponges act as important microhabitats and promote biodiversity by harboring a wide variety of macrofauna and microbiota, but little is known about the relationships between the sponges and their symbionts. This study uses DNA barcoding to examine the macrofaunal communities associated with sponges of the central Saudi Arabian Red Sea, an understudied ecosystem with high biodiversity and endemism. In total, 185 epifaunal and infaunal operational taxonomic units (OTUs) were distinguished from the 1399 successfully-sequenced macrofauna individuals from 129 sponges representing seven sponge species, one of which (*Stylissa carteri*) was intensively studied. A significant difference was found in the macrofaunal community composition of *Stylissa carteri* along a cross-shelf gradient, and sponge abundance increased with proximity to shore. The difference in macrofaunal communities of several species of sponges sampled from one location was found to be significant as well, using OTU presence (binary Jaccard diversity index). Four of the seven sponge species collected were dominated by a single annelid OTU, each unique to one sponge species. A fifth was dominated by four arthropod OTUs, all species-specific as well. Results will also be presented based on the diversity of the microbial communities found in the sponge samples. As climate change and ocean acidification continue to modify coral reef ecosystems, understanding the ecology of sponges and their role as microhabitats may become more important.

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EVALUATING POTENTIAL MECHANISMS UNDERLYING TROPHIC ASSEMBLAGE SHIFTS IN REEF FISHES FROM SHALLOW TO MESOPHOTIC DEPTHS IN HAWAII. (Abstract ID: 28224)

Herbivorous reef fishes are considered integral components of healthy coral reef ecosystems, yet initial studies of mesophotic coral reefs (>30m) indicate vast reductions in herbivorous reef fish communities compared to their shallow congeners despite observations of high algal abundance at mesophotic depths. Preliminary hypotheses regarding the reduction in herbivorous fishes with depth propose that 1) decreased light levels may reduce habitat quality, 2) reductions in water temperature inhibits fishes' digestion of algal tissues, and 3) algal abundances are reduced or chemically defended on deep reefs. We conducted surveys along stratified depth gradients in West Hawaii to assess variability in reef fish trophic assemblages, temperature, and habitat metrics with depth. We then conducted choice experiments to determine the palatability of common algal species in mesophotic depths. Our findings support previous studies of reduced herbivorous reef fish abundances with depth, yet the absence of herbivores at depth does not appear to be associated with variations in temperature, habitat complexity or turf algal cover. Instead, herbivore reductions were positively associated with reductions in coral cover and negatively associated with increasing macroalgal cover with depth. Algal choice experiments revealed that deep algal species are edible and quickly consumed by shallow herbivorous fishes. These findings suggest changes in herbivore populations with depth are more complex than habitat quality, temperature, or food availability previously hypothesized.

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UNWINDING THE MYSTERY OF CORAL BROADCAST MASS SPAWNING, SIGNALING CASCADES AND THE IMPORTANCE OF MOONLIGHT (Abstract ID: 28571)

The geophysical cycles in our planet Earth are mirrored in evolving endogenous clocks allowing organisms to anticipate daily and seasonal rhythms and to adjust their biochemical, physiological and behavioural processes accordingly. Many corals participate in a yearly cycle known as the mass-spawning event. This reproductive event is one of earth's most prominent examples of synchronised behaviour and coral reproductive success is vital to the persistence of coral reef ecosystems. Although several environmental cues have been implicated in the timing of mass spawning, the specific sensory cues that function together with endogenous clock mechanisms to ensure accurate timing of gamete release are largely unknown. Recently we have characterized the transcriptomes of two coral species A. millepora and A. digitifera by sampling colonies at different timelines; before, during and post spawning. Our finding show that moonlight is an important external stimulus for mass spawning synchrony and describe the potential mechanisms for the signalling cascades that ultimately result in gamete release. We identify transcripts

that vary only on the spawning night, with upregulation of light-sensing molecules and rhodopsin-like receptors that initiate different signaling cascades such as the glutamate pathway, SMAD signaling pathway, WNT signaling pathway, neuroactive ligand-receptor interaction and calcium signaling. These signaling pathways are involved in cell cycling, cell movement, tissue polarity, focal adhesion and cytoskeleton reorganization, which together, lead to gamete release.

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RECOVERY AND REORGANISATIONS OF CORAL REEFS DUE TO THE COMBINED EFFECT OF OCEAN WARMING AND ACIDIFICATION IN THE GULF OF MANNAR AND PALK BAY, INDIA (Abstract ID: 29414)

Episodic bleaching phenomena occurred around the globe since 1998 recurrently including India. Recurrent bleaching incidences resulted in the loss of live coral cover along with the changes in the coral community structure of the reefs. After the 1998 and 2002 massive bleaching phenomena in the Gulf of Mannar and the adjacent Palk Bay, significant recovery of live coral cover was observed. Conversely, after the 2005, 2006, 2010 and 2013 bleaching incidences, coral cover has continued to decline in response to multiple smaller bleaching events in the Palk bay reefs and Gulf of Mannar. Despite the severity of bleaching, recovery of coral species belongs to the families such as Porites, Favites, Montastrea, Favia, Platygyra, Symphillia and Goniastrea have been recorded. However, significant decline was also observed among the dominant reef builders belong to the families viz., Acropora, Montipora, Pocillopora and Galaxea in the reefs of Palk bay and some reefs in the Gulf of Mannar after successive bleaching events. In spite of the catastrophic bleaching events and associated triggering factors such as ocean acidification, data sets of the biophysical status of corals from 1996 to till date revealed that the transition of coral reef ecosystem with slight changes in the ecosystem functions in the reefs of Gulf of Mannar and Palk Bay is evident. The study also stressed the need for strong commitment and management towards maintain ecosystem services of the coral reef ecosystem of the Gulf of Mannar Marine Biosphere Reserve and Palk Bay resilience by restoring healthy levels of herbivory, macroalgal cover, streamlining the fishing practices and monitor the coral recruitment.
http://www.nrcbsmku.org/FAC%20PROF/jayakumar.pdf

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THREE CORAL HEALTH PROJECTS IN COLLABORATION WITH NOAA EDUCATIONAL PARTNERSHIP PROGRAM (Abstract ID: 28168 | Poster ID: 684)

NOAA's Office of Education has several programs, one is the Educational Partnership Program (EPP) where NOAA scientists submit proposed opportunities for students participation in various projects. If selected, the NOAA opportunity is circulated among students associated with four focused centers and corresponding NOAA line offices; the Environmental Cooperative Science Center (ECSC) / NOS, the NOAA Center for Atmospheric Science (NCAS) / NWS, the Cooperative Remote Sensing Science and Technology (CREST) / NESDIS, and the Living Marine Resources Cooperative Science Center (LMRCSC) / NMFS. We present three examples of the successful partnerships between NOAA coral science projects in Hawai'i and Puerto Rico and students provided via the EPP and how these projects address the goals of bridging science to management and policy.

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CORAL REEF SOUNDSCAPES MAY NOT BE DETECTABLE FAR FROM THE REEF (Abstract ID: 28064)

Biological sounds produced on coral reefs may help pelagic larvae identify suitable settlement habitat. Evidence that reef sound may play such a role has been unearthed in several studies. Some coral reefs may also be high amplitude sources, suggesting that this sound could be a long-range settlement cue. To date there have only been a small number of studies that have explored how far sound pressure might propagate. In addition to pressure, sound fields are composed of particle motion, which is the vibratory back and forth movement of acoustic particles and the component of the sound field that most fishes and invertebrates are able to detect. However, there are no field measurements of particle motion propagation. To address this deficiency, both sound pressure and particle motion were recorded at a range of distances from one Hawaiian reef at dawn (to capture fish choruses) and mid-morning (as a comparison) on three separate days. Sound pressure attenuated with distance from the reef at dawn but not during the mid-morning. Similar trends were apparent for particle velocity but with more variability. Average levels were low and perhaps too faint to be used as an orientation cue over long distances. However, individual transient sounds, which exceeded the mean values by up to an order of magnitude, might be detectable at greater distances from the reef, depending on their attributes and the hearing abilities of the larva. If sound is not being used as a long-range cue, it might still be useful for near-reef orientation at night or for habitat selection within a reef.

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VISUALIZING THE 3D SPATIAL DYNAMICS OF CHEMICAL AND MICROBIAL SIGNATURES ON CORALS (Abstract ID: 28380 | Poster ID: 108)

Coral reefs are one of the planet's most threatened marine ecosystems. Similar to other animals, corals possess a highly complex microbial community that facilitates optimal physiological function for both themselves and their surrounding environment. Unexpected microbial and chemical shifts can have severe consequences on the survival of corals, and thus the entire ecosystem. The development and implementation of innovative macro- and micro-scale imaging mass spectrometry tools has allowed for rapid identification of chemical signatures from organisms. This technology has been combined with emerging photogrammetric techniques to provide, for the first time, 3D spatial visualization of coral molecular features. Molecular profiles were obtained from the interaction among several species of Hawaiian corals. Distinct diurnal metabolic patterns were observed in the Montipora capitata coral affected with tumor-like lesions. Using open-sourced metabolomic profiling tools, such as Global Natural Product Social molecular network (GNPS.ucsd.edu), several coral associated specialized metabolites were identified. Furthermore, by combining imaging mass spectrometry and 16s microbial profiling, correlations between coral metabolites and the spatial distribution of bacterial communities throughout the coral colony surface were characterized in 3D space. By implementing a highly interdisciplinary analytical workflow in chemistry, biology and virtual reality technologies, this study provides an innovative platform to better understand the molecular space of complex coral ecosystems.

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WORKING TOGETHER TO UNDERSTAND, QUANTIFY AND MANAGE FOR TIPPING POINTS ON THE REEFS OF HAWAII (Abstract ID: 30096 | Poster ID: 590)

Tipping points occur when small shifts in human pressures or environmental conditions bring about large, sometimes abrupt changes in a system – whether in a human society, an ecosystem or our planet's climate. This talk introduces the Ocean Tipping Points project, a multi-year, multi-organization effort to advance our understanding of abrupt shifts in marine ecosystems and improve ocean management. We present results of our research on ecosystem shifts on reefs of Hawaii and discuss implications for reef management and the benefits of collaborative engagement between scientists and practitioners. In this multi-sector, interdisciplinary collaboration, scientists and governmental and non-governmental experts are working together to better understand complex reef ecosystems and develop management tools to sustain them. By integrating an unprecedented body of newly synthesized benthic and fish community data and novel, spatially explicit datasets representing environmental and anthropogenic drivers, we provide evidence for the existence of multiple reef regimes across the Main Hawaiian Islands and nonlinear relationships between regimes and their drivers. These quantified threshold responses of reef state to multiple stressors provide a useful set of reference points to inform targets for reef protection and restoration. Using tradeoff models we examine costs and benefits of different management actions aimed at reaching those targets. We

conclude by demonstrating how these analyses are supporting efforts to mitigate local stresses and enhance resilience of Hawaiian reefs.
http://oceantippingpoints.org

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PREDICTING CLIMATE IMPACTS ON HAWAIIAN CORAL REEF FISHERIES: ARE CONTEMPORARY SPATIAL MANAGEMENT STRATEGIES SUSTAINABLE? (Abstract ID: 28214)

Simulation models of coral reef ecosystems predict severe negative ecological responses to climate change. We evaluate the potential consequences of spatial harvesting strategies for tropical reef fisheries of the Hawaiian Islands under two IPCC climate scenarios that accounted for spatial heterogeneity in environmental forcing functions, including climate change-mediated disturbances and nutrification from terrestrial run-off. We simulated a suite of scenarios to test the interaction between the proportion of marine habitat area closed to fishing (as no-take MPAs) at 0%, 10%, or 20%, habitat loss from coral bleaching, and the effect of elevated nutrients on interference competition between benthic functional groups, at a 100 year time horizon. We found that the establishment of MPAs increased both biomass and catch of reef fish across all functional groups (herbivorous, small piscivorous, and large piscivorous) for all scenarios as a shift from coral-dominated to algae-dominated habitats drove a lagged increase in herbivorous fish populations and their predators. However, heightened nutrification of the same reefs protected from fishing resulted in a diminished protection effect, rendering coral and macroalgal cover in high-nutrient, high MPA proportion scenarios similar to low-nutrient scenarios with far less fishing protection. A future wherein reefs retain low coral cover and a functional biomass of herbivores is demonstrated as possible in the context of spatial fishery management under climate change.

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THE EVOLUTION OF BEST PRACTICES TO PREVENT, ASSESS, AND MITIGATE CORAL REEF IMPACTS IN THE ATLANTIC/CARIBBEAN (Abstract ID: 29655)

Large-scale coastal development and infrastructure projects have and will continue to result in considerable loss of coral reef habitats world-wide. Best practices for coral reef impact avoidance, assessment, and mitigation options have evolved considerably in recent years in the Atlantic/Caribbean. However, caution is needed in applying impact assessment design achievements from one project to others as regional and local differences in oceanographic conditions and habitat types may require adjustments in order to replicate the initial success. Effectively capturing lessons from planned projects and socializing the lessons learned with participants involved in the planning process is also essential to ensuring projects are designed in a manner that prevents and minimizes coral reef impacts to the extent possible. The progress made in these areas in the Atlantic/Caribbean is applicable to other coral reef regions.

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SHOULD ENVIRONMENTAL POLICY AND ADVOCACY FOCUS ON THRESHOLDS OR DEGRADATION? (Abstract ID: 30148)

Uncertainty is unavoidable when addressing the threats posed by everything from greenhouse gas emissions, to nutrient pollution, to ocean acidification. Unfortunately that uncertainty can be used as an excuse for not taking action. Inspired by some game theoretic results, we examine several case studies to determine whether focusing on degradation with uncertainty about its magnitude or focusing on thresholds with uncertainty about where those thresholds lie differ in their ability to promote action and appropriate policy responses. While our case studies are drawn from a wide variety of systems, they apply to how we approach the management and conservation of coral reefs.

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COPING WITH CATASTROPHE: BEHAVIORAL FLEXIBILITY ENABLES A LONG-LIVED BENTHIC PISCIVORE TO SURVIVE IN RAPIDLY DEGRADING REEFS (Abstract ID: 28636)

Coral reefs have rapidly lost their architectural complexity in the last two decades from repeated mass-bleaching catastrophes. Understanding the ability of species to cope with this change is critical to determine winners and losers in the face of climate change. To understand which species are surviving in degrading coral reefs, we studied the distribution of a guild of structure-dependent, long-lived predators (groupers) in the Lakshadweep archipelago, along a gradient of reef structure, which has declined with repeated disturbances since 1998. Three of the six most abundant grouper species were seen only in reefs which had a structural canopy of >60 cm. However, the peacock grouper (Cephalopholis argus) dominated species assemblage across the gradient. We explored mechanisms of behavioral flexibility that enables C. argus to survive in degraded reefs. Where potentially less flexible species drop out, C. argus shows a dramatic switch in foraging behavior beyond the 60 cm structural threshold. Territory sizes increase exponentially as prey and competitor densities decline. But C. argus maintains a highly selective diet even in the most degraded reefs, by modifying its foraging mode from a structure-dependent 'ambush' to a structure-independent 'widely- foraging' mode. The ability to maintain trophic position with behavioral flexibility may be a key trait, allowing species to adapt to structurally declining reefs. With rapid environmental change, these adaptable species may perform important predatory functions, maintaining the overall resilience of reefs.

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CHARACTERIZING CHEMICAL COMPOSITION OF SIZE-FRACTIONATED PARTICULATE ORGANIC MATTER IN A FRINGING CORAL REEF OF MALAYSIA (Abstract ID: 29146 | Poster ID: 218)

Particulate organic matter (POM) is comprised of microplankton, nanoplankton and picoplankton depending on its size definition. It is assumable that each fraction has different compositions of organisms such as phytoplankton, flagellates and bacteria due to their size ranges. Our goal of this study is to characterize the size-fractionated POM by chemical compositions, especially organic compounds and stable isotopes. Seawater samples were collected at Bidong Island, Malaysia (tropical), Sesoko Island (subtropical) and Sagami Bay (temperate), Japan in 2014 and 2015. Seawater was filtered through nylon meshes with different pore sizes: 2, 20, 100 and 180 μm. POM in each size fraction was collected on GF/F filters. Organic compounds were detected and identified by pyrolysis gas chromatography/mass spectrometer, and stable isotopes were measured by elemental analyzer/isotopic ratio mass spectrometer. The concentration of chlorophyll-a (chl-a) was measured by a fluorometer. In all the studied sites, the smallest size fraction indicated the highest chl-a concentrations, implying a large contribution of cyanobacteria. In Bidong Island, there were no significant differences in stable carbon isotopic values among the size fractions. On the other hand, the stable carbon isotopic values values in Sesoko Island and Sagami Bay were significantly different between the fractions larger and smaller than 20 μm. Our results implied that the difference in organic matter composition of POM could be well characterized by the abundance of micro- and nano-plankton.

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CORAL TRANSPLANT SUITABILITY STUDY OF OKINOTORISHIMA BY THE SUPERPOSITION OF CORAL DISTRIBUTION AND HABITAT CONDITION. (Abstract ID: 28533 | Poster ID: 487)

In the aim of enlarging coral distribution, a coral transplantation suitability study was conducted at the inner reef of Okinotorishima,which is located at the southernmost end of Japan. The study was carried out by superimposing the coral distribution on the habitat conditions in the coral reef by using GIS (Geographic Information System). The following four conditions are ideal for selecting transplantation. (A) Suitable locations for coral to habit. These locations were selected from high coral coverage places, places of less high water temperature frequency, and low stress places counted by Shields numbers which indicate the movement of gravel. (B) Locations where the coral coverage temporarily declined. These were selected from places where the coral coverage temporarily declined according to secular-change comparison by satellite image analysis. (C) Locations where transplanted corals could work as a source of coral larvae. These were selected by using larvae diffusion simulation. (D) Locations where ideal substrates for coral exist. These were selected from places where there are knolls that are higher than 50cm from the seafloor, which is higher than the inhabit height of the likes of Acropora tenuis – the objectives of the transplantation. Based on a result of the study, the coral transplantation has been conducted from 2014 once year. Transplantations for 400 colonies have been carried out and the survival rate maintains high state. Monitoring after the transplantation and adaptive management will continue into the future.

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COMMUNITY AND ECOSYSTEM ASPECTS OF THE RECOVERY OF ATLANTIC ACROPORID CORALS: SCIENCE IN SUPPORT OF STEPWISE STEWARDSHIP GOALS (Abstract ID: 28926)

The science of species recovery for the Caribbean acroporid corals has focused largely on propagation and survival of individual coral colonies, leaving to later the process of restoring and maintaining the coral reef community as a whole. Later is now. We detail a recovery process that begins with acroporid restoration and culminates in the restoration of west Atlantic coral reef ecosystem services in an era of anthropogenic climate change momentum. The steps in this process are: (1) restoration of self-sustaining populations of the two acroporid species and their hybrid; (2) acroporid restoration triggers reassembly of a web of ecological interactions similar to reef surface dynamics prior to 1980; (3) resumption of framework construction sufficient to keep pace with sea level rise, by acroporids in concert with other framework-builders; and (4) ensurance that restored reef surface framework-building communities and their suite of associated species can sustain and renew themselves spontaneously through an at least several century-long climate recovery period. We critically examine the field interventions and science required to achieve each of these four milestones, assess potentially acceptable alternative outcomes, and consider the enabling environment of laws and actions essential for any of this to occur.
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SURVIVORS OF ACROPORA MURICATA COLONIES IMPACTED BY DRUPELLA CORNUS OCCURRING UNDERNEATH PADINA BORYANA: IMPLICATIONS FOR MULTIPLE STRESSORS MANAGEMENT (Abstract ID: 29579 | Poster ID: 419)

The density of the corallivorous marine snail *Drupella cornus* and the percentage of *Acropora muricata* colonies in the coastal zone covered by the macroalga *Padina boryana* were studied over summer (March) and winter (August) months of the years 1998 and 2010-2014 at Flic-en-Flac, Mauritius. In 1998, the mean density of *D. cornus* was <1.00 $m^{-2}$ for both months and the percentage of coral colonies out of 15 covered by *P. boryana* were 11.11% and 8.89% for March and August, respectively. In 2010-2014, the density of *D. cornus* and the percentage of coral colonies covered by *P. boryana* were significantly higher in summer (17.00-30.60 $m^{-2}$; 62.22-93.33%) than in winter (0.40-5.20 $m^{-2}$; 15.56-26.67%), on account of the higher rainfall, nutrient levels and temperatures. The density of *D. cornus* and the percentage of coral colonies covered by *P. boryana* varied throughout the study period, with higher density of *D. cornus* occurring on *A. muricata* colonies covered by *P. boryana*, especially in summer. Although the coastal coral colonies have been reported to be less prone to thermal bleaching than the reef flat ones, the occurrence of *D. cornus* on colonies covered by *P. boryana* indicates that the coral might be prone to predation. This might have repercussions for multiple stressors management in terms of damage caused by *D. cornus* on*A. muricata* in Mauritian waters, especially under a globally changing ocean climate.

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POLICY DEVELOPMENT ON IMPLEMENTING AN ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT IN MALAYSIA IN FULFILLING OBLIGATIONS UNDER THE CORAL TRIANGLE INITIATIVE (Abstract ID: 28374)

Increased understanding of the interactions among different marine ecosystem components such as fish, people, habitats, and climate has led to the recognition and adoption of the Ecosystem Approach to Fisheries Management (EAFM) in the Coral Triangle Initiative (CTI). EAFM extends beyond fish in the seas and people in boats, to a marine environment that includes coral reefs and mangroves, and human activities covering fishers, fishing communities, and coastal development. Target 1 of Goal 2 under CTI stresses on implementation of EAFM through the adoption and implementation of strong legislative, policy, and regulatory frameworks. While Malaysia has generally been proactive in integrating EAFM into the country's natural resource regime, beginning with initiatives in Sabah, progress has been generally slow in incorporating the required changes into national policies and regulations. The experience however shows that EAFM can be scaled-up from existing pilot sites or localized management to a broader implementation strategy. Although EAFM implementation is usually deemed the responsibility of fishery agencies, its full implementation at the national level requires coordination and cooperation with other agencies and stakeholders responsible for managing related activities that impact on the marine ecosystem. Successful EAFM fisheries management initiatives in Malaysia are to be further raised by studying the dynamics of marine ecosystems, developing indices of ecosystem health, and setting management targets as a way forward.
http://www.mima.gov.my/v2/

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A COMPARATIVE STUDY OF MOLECULAR PHYLOGENY AND SEXUAL REPRODUCTIVE CHARACTERISTICS IN *ZOANTHUS KUROSHIO*(HEXACORALLIA, ZOANTHARIA, ZOANTHIDAE) (Abstract ID: 28757 | Poster ID: 70)

Genus *Zoanthus* (Hexacorallia, Zoantharia, Zoanthidae) spp. are widespread, zooxanthellate, colonial benthos. In coral reefs, they are common from intertidal zone to 30 m offshore. Occasionally, they have large influence on neighboring benthos by limiting space availability. Research on *Zoanthus*spp. sexual and asexual reproduction is only fragmentary, and more work is needed to understand their dynamics within coral reef ecosystems.*Zoanthus kuroshio* is abundant in the intertidal zone of Okinawa island, Japan. Basic information such as sexuality and spawning timing is unknown. So we examine the sexual reproductive characteristics of tagged*Z. kuroshio* colonies, specifically colony sexuality, gametogenesis periods, and spawning timing in Okinawa island. Results showed the gametogenesis period of *Z. kuroshio* is from May to July, and oogenesis sets in earlier than spermatogenesis. *Z. kuroshio* is partially protogynous simultaneous hermaphrodites, and we observed colonies of three different sexualities; males, females and hermaphrodites. Spawning timing did not overlap between the colonies of each sexuality, and hence it can be thought that there was reproductive isolation between colonies. This leads to the possibility that *Z. kuroshio* contains more than one species. Accordingly, we conducted phylogenetic analyses of nuclear ribosomal ITS and 18S and mitochondrial 16S sequences. We discuss how the molecular phylogeny reflects sexual reproductive characteristics in the tagged colonies.

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MODELS OF CORAL DEMOGRAPHY DURING REEF RECOVERY PROVIDE QUANTITATIVE PROJECTIONS OF CORAL COMMUNITY TRAJECTORIES AND ESTIMATES OF REEF RESILIENCE (Abstract ID: 28487)

Coral reefs are inherently resilient to perturbations. Yet coral populations are declining in many places. The question why is this so has focused much attention on identifying underlying drivers of reef resilience. How coral communities respond to disturbance appears to depend on complex interactions of abiotic and biotic processes acting at multiple scales. Understanding these processes quantitatively requires an approach that integrates empirical individual-level demography with population simulations designed to elucidate community dynamics. We used an Integral Projection Model (IPM) framework to investigate the drivers of coral community recovery in Moorea, French Polynesia. Reefs there are recovering from disturbances that decimated coral populations, providing an excellent model system to evaluate mechanisms influencing early-stage community recovery and longer-term resilience. We quantified recruitment, growth and survival of the three dominant coral genera over multiple spatial scales during the first 5 years of reef recovery. We used estimates of coral performance to construct an IPM that predicts community trajectories based on the population dynamics of the three genera. Our results indicate that spatial variability in coral recruitment, species' life histories, density-dependent regulation and local reef environment interact at different scales to influence recovery. Our approach provides the foundation to quantitatively evaluate the degree to which coral communities are resilient, and to predict the effects of future disturbances such as mass bleaching events.

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ECO-TECHNOLOGICAL MANAGEMENT OF ATOLL ISLANDS AGAINST SEA LEVEL RISE (Abstract ID: 28577)

Atoll countries occupy low, narrow islands and are very vulnerable to sea level rise. However, the current problems of inundation and beach erosion reported to occur in atoll island countries result mainly either from natural processed or from local problems associated with concentration of the population to the capital islands. Atoll islands are formed by geo-ecological processes of coral and foraminifer production and their sedimentation. Deterioration of coral reef ecosystem has lead to degradation of reef formation potential to keep up with the rising sea and reduction of sand production to form the islands. Causeways between islands and jetties constructed perpendicular to coastlines prohibit sand transportation. Vertical seawalls do not enhance but inhibit sand sedimentation. These local problems decrease geo-ecological resilience to future accelerating sea level rise. For wise management of atoll island countries against sea level rise, ecosystem-based management including rehabilitation of the damaged coral reefs and minimum control of wave and current to enhance accumulation of sediment above high water level is fundamental together with grey (concrete) technology. Any grey countermeasure plans must not contradict the natural production, transportation and

sedimentation processes. The measures must be instituted with appropriate governance that incorporates traditional forms in the context of the globalized economy and society.

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DIFFERENT LEVELS OF ANTRHOPOGENIC IMPACT INFLUENCE CORAL LARVAE SETTLEMENT AND RELATED BACTERIAL BIOFILM COMMUNITIES IN THE SPERMONDE ARCHIPELAGO, INDONESIA (Abstract ID: 29399)

Recruitment of coral larvae is one of the key factors for coral reef recovery. Settlement cues emitted from bacterial biofilms play a vital part in larval settlement and metamorphosis. These cues depend largely on the community composition of the biofilms, which can change drastically with altered environmental conditions and in turn may affect larval settlement behavior. This study investigated bacterial community composition and coral larvae settlement at three sites with differing distance from shore, and thus different levels of human impact and water quality, in the Spermonde Archipelago, Indonesia. Bacteria and coral larvae were investigated on natural reef substrate and artificial ceramic tiles. Bacterial communities were comprised largely of *Gammaproteobacteria, Alphaproteobacteria, Cyanobacteria* and *Flavobacteria* and were strongly correlated with water quality and benthic community composition. No coral recruits were found at the inshore site with the highest anthropogenic impact. Between the other two sites coral recruitment was similar. Path analysis modelling revealed that coral recruitment was influenced directly by water quality and the bacterial community composition, as well as indirectly due to the influence of water quality on the bacterial community. This study shows that negative anthropogenic influences on water quality affect bacterial community compositions and in turn coral larvae recruitment. It also highlights the importance of taking these often neglected factors into account in evaluating the recovery potential of coral reefs.

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CAN COMPETITION MAINTAIN BIOGEOGRAPHIC BORDERS? (Abstract ID: 28349)

The role for species interactions in the generation and maintenance of biogeographic borders, where multiple species range edges meet, is unclear. Progress has been hindered by an over-reliance on indirect inference and the use of low-resolution, opportunistic data. To determine the role of competition more explicitly, we are collecting small grain behavioural data across a large geographic extent at biogeographic borders. We target these locations because sister species that have evolved allopatrically in adjacent biogeographical provinces are hypothesised to compete strongly on secondary contact, potentially explaining why these species do not further expand their ranges. Moreover, we might also expect these species to be more aggressive at range boundaries compared with widespread species that traverse biogeographic regions. We test these ideas with Indo-Pacific butterflyfishes (Chaetodontidae). Butterflyfish sister species typically have one species in each of two major biogeographic provinces - the Indian Ocean and the Pacific Ocean - and co-occur at contact zones around a few small islands between these provinces. We visited three contact zones within the central Indo-Pacific (Christmas Island, Bali, Iriomote) and one central control region (Philippines) and recorded >3000 interactions between species pairs. Here, I present preliminary data from these locations at the start of a larger project to determine whether competition could be a significant force in the maintenance of biogeographic boundaries.

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`IKE KAI: AN INNOVATIVE AND ENGAGING CURRICULUM FOR THE DIVISION OF AQUATIC RESOURCES (Abstract ID: 29885)

The State of Hawai'i Makai Watch (MW) Program is a collaborative statewide program whereby citizens and NGOs systematically assist the Department of Land and Natural Resources (DLNR) in its mandate to manage marine and coastal resources. A gap was recently identified that is preventing the MW program from fully achieving its mission of building capacity for community stewardship - a lack of foundational training for MW volunteers in marine science and resource management. The goal of the 'Ike Kai curriculum project was to fill this gap by increasing MW volunteers' baseline knowledge of marine science and marine resource management, including traditional and modern use and stewardship. The term "'Ike Kai" means "to know, feel, experience, be aware, and comprehend the ocean". The 'Ike Kai curriculum was designed to inform monitoring projects, outreach activities, and marine fishery and habitat conservation projects being undertaken by these communities while strengthening the relationship with resource management agencies. To make the curriculum training relevant to each unique community, place-based material including a field kit to support outreach and monitoring activities were provided to each group. Future uses include creating an online version as a tool Environmental Court judges can use when sentencing first time resource violators in Environmental Court.

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VISUAL DECISION TOOLS: AN INNOVATIVE TECHNIQUE FOR BUILDING OCEAN LITERACY (Abstract ID: 28519)

Visual Decision Tools are interrogated via a visual index rather than read - think Visual Hyperlinking - and can be in digital or print form. They have the potential to empower individuals to rapidly interrogate factual information and solve complex problems without the need for formal knowledge or prior training. Applications include marine identification and capacity building for reef monitoring and conservation. Following 6-years of testing by the Coral Identification Capacity Building Program, we demonstrate how Visual Decision Tools achieve dramatic improvements in a user's capacity to identify corals using the Coral Finder. Results from workshops in the Indo-Pacific show how this approach instantly empowers non-coral specialists with minimal training. Coral-specialists also benefited from the process. Key learnings were used in the design of the Reef Finder - a Visual Decision Tool that enables the user to put any reef organism into a taxonomic group and give visible reasons why. Results are presented showing how the Reef Finder's visual approach dramatically builds the capacity of individuals to recognise a broad range of fish and invertebrate groups with little training or formal knowledge. Visual Decision Tools can unlock existing technical tomes and datasets: e.g. retro-fitting a visual index can be a powerful way to add ease-of-use to information arranged in traditional alphabetical or hierarchical structures. Users of Visual Decision Tools are enthused by the instant success they can achieve. Design guidelines are presented for implementation in print, web and app.

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MODELING MARINE METAPOPULATION CONNECTIVITY: UNDERSTANDING OCEANOGRAPHIC AND LIFE HISTORY INTERACTIONS ACROSS MULTIPLE SPATIAL SCALES (Abstract ID: 29805 | Poster ID: 520)

Assessing the degree of connectivity within and among reef sites in a metapopulation is central to understanding persistence of species that inhabit patchy ecosystems. Larval dispersal is determined by numerous oceanographic and biological processes that operate at multiple spatial and temporal scales. Therefore, the probability of successful dispersal, both locally and regionally, may not be simply a function of distance from natal site. This relationship is examined by analyzing the degree of connectivity of the Orange clownfish *Amphiprion percula* at two spatial scales (around-island and bay-wide) in Kimbe Bay, Papua New Guinea. Comparing the observed natal-to-settlement events to all possible anemone-to-anemone connections reveals that there is bias towards shorter dispersal distances at the local around-island (up to 1 km) scale in three different years despite potentially variable oceanographic conditions. Bay-wide (up to 100 km) connectivity is also a regular occurrence, with exchange of larvae across some of the more distant anemones. These observations of larval dispersal across coral reef habitats are compared to oceanographic transport estimates from a biophysical model that examines the interplay of ocean circulation and life history. Temporal and spatial variability of oceanographic transport can generate directional and episodic patterns of connectivity even in systems that appear well mixed by eddies. Larval survival and pelagic larval duration also play a critical role in marine metapopulation dynamics of organisms with a bipartite life cycle.

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BIOGEOGRAPHIC COMPARISON OF *LOPHELIA*-ASSOCIATED BACTERIAL COMMUNITIES IN THE WESTERN ATLANTIC (Abstract ID: 28338)

Over the last decade, publications on deep-sea corals have tripled. Most attention has been paid to *Lophelia pertusa*, a globally distributed scleractinian coral that creates critical three-dimensional habitat in the deep ocean. The bacterial community associated with *L. pertusa* has been previously described by a number of studies at sites in the Mediterranean Sea, Norwegian fjords, off Great Britain, and in the Gulf of Mexico

(GOM). However, use of different methodologies prevents direct comparisons in most cases. Our objectives were to address intra-regional variation and to describe the conserved bacterial core community. We collected samples from three distinct colonies of *L. pertusa* at each of four locations within the western Atlantic: three sites within the GOM and one off the east coast of the United States. Amplicon libraries of 16S rRNA genes were generated using V4-V5 primers and 454 pyrosequencing. The dominant phylum was Proteobacteria (75–96%). At the family level, 80–95% of each sample was comprised of five groups: Pirellulaceae, Pseudonocardiaceae, Rhodobacteraceae, Sphingomonadaceae, and unclassified Oceanospirillales. Principal coordinate analysis based on a weighted unifrac distance showed a clear distinction between the GOM and Atlantic samples. Interestingly, the replicate samples from each location did not always cluster together, indicating there is not a strong site-specific influence. A core bacterial community, conserved in 100% of the samples, was dominated by the alphaproteobacterial genus *Novosphingobium*.

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BALANCING THE BUDGET: A NEW WAY TO ASSESS HERBIVORE FUNCTION ON FISHED AND UNFISHED REEFS ACROSS MAUI, HAWAII (Abstract ID: 29951)

Herbivore grazing pressure on coral reefs is considered a major driver in the maintenance of coral dominance over algae in competition for space. However few studies have attempted to quantify and compare rates of consumption by herbivores with production of new biomass by the algal community. Here, we calculate a budget for herbivore consumption and algal growth on Hawaiian coral reefs by multiplying bootstrapped distributions of field-measured variables. Data were collected at reefs around Maui including Kahekili Herbivore Fisheries Management Area, a near-shore reef impacted by nutrient pollution and fishing and established in 2009 to prohibit take of herbivores. At Kahekili, our results show that despite herbivore protection, algal production currently exceeds the grazing capacity of the herbivorous fish community by three to four times. While some of this production is likely consumed by urchins or converted to detritus, increased herbivore biomass will be required to effectively reduce algal abundance. Despite the gap, larger size classes of herbivores, particularly of the scraper/excavator feeding guild, are contributing more to consumption in recent years, which could have additional feedbacks that promote reef-building taxa. Island-wide, we found that net algal biomass production was lowest at reefs with high coral cover even when fish biomass at these reefs was comparable or less than on low coral cover reefs. The results of this study suggest lower herbivore biomass is required to maintain a healthy reef than to restore a degraded reef.

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EXTREME FUNCTIONAL DIFFERENCES AMOUNG PALAUAN REEF CORALS AND THEIR SYMBIOTIC ALGAE (Abstract ID: 29651)

The inshore coral reef habitats of Palau resemble temperature and pH conditions similar to those projected by 2100 AD. We compared the trophic dynamics and niche width of eight species of Scleractinia found in both inshore and offshore reefs. Stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) were used to deduce the relative importance of photosynthesis and heterotrophy to corals living in each habitat. Coral from inshore habitats were found to associate with *Symbiodinium trenchii* (type D1a). Isotopic values of the animal's tissue, symbiotic algae, and skeleton revealed that these corals relied on zooplankton and particulate organic matter (POM) for metabolism considerably more than conspecifics from offshore reefs. Offshore corals depended more on autotrophy and harbored different species of symbiont. As expected, thermal experiments revealed offshore corals were more negatively impacted by increased temperature. However, comparisons of nutrient allocation under normal and stressful conditions indicated little, or no, significant tradeoffs in the physiological performance of some stress-tolerant host-symbiont pairings, contrary to prevailing assumptions. These findings indicate that while inshore corals rely more on a combination of energy sources to acclimatize to stressful environments, their symbioses are maintained with minimal cost to animal growth. Our findings show how coral metabolism may need to shift to cope with increased ocean warming.

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ETIOLOGICAL AGENTS OR SECONDARY OPPORTUNISTS? FREQUENT MONITORING AIDS IN ASSESSING THE ROLE OF *VIBRIO* BACTERIA IN DISEASE OF *ACROPORA PALMATA* (Abstract ID: 28074 | Poster ID: 156)

*Vibrio* bacteria are frequently associated with disturbed states of the coral microbiome due to disease or thermal stress. We examined the seasonal dynamics and association of *Vibrio* with disease lesions on the Caribbean coral, *Acropora palmata* in the Florida Keys, USA. We found ~4X the concentration of cultivable *Vibrio* on *A. palmata* lesions compared to intact tissue. It is often difficult to establish the role of particular microbial taxa, such as *Vibrio*, in coral disease because samples are collected after disease signs are already apparent and lesion age is unknown. *Vibrio* may be primary etiological agents of coral disease or part of secondary opportunistic infections. To further investigate the association of *Vibrio*with *A. palmata* lesions and examine potential community-level successional patterns, we monitored Looe Key Reef for new lesion outbreaks 3-5 days per week during July 2015. Samples from new lesions <24 h old and 3, 6, and 8+ day-old lesions were processed for 16S rRNA sequencing and qPCR. To examine the diversity of *Vibrio* associated with lesioned and intact tissue of *A. palmata*, we processed more than 170 *Vibrio* isolates for phylogenetic analysis. Unique isolates were chosen for further analyses with the aim to provide new insights into metabolic and virulence capabilities of coral-associated *Vibrio*. This study highlights the importance of frequent monitoring during disease outbreaks to attribute lesion causality.

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PHYSICAL MECHANISMS OF ISLAND BUILDING – THE IMPLICATIONS OF OVERWASH FOR ISLAND MAINTENANCE (Abstract ID: 28506)

The future stability and continued persistence of low-lying coral reef islands has generated global concern in recent decades as sea levels rise and the frequency of storms increases. Increased shoreline erosion and wave-induced flooding are widely accepted impacts of such environmental changes. However, such assertions are commonly based on an assumption that the island shoreline is static. Recent studies have indicated that islands have the potential to migrate in planform on their reef surfaces, indicating that islands are dynamic features that can adjust their shape and position in response to changing boundary conditions. The three-dimensional nature of island dynamics have not been well quantified. This paper adds to understanding of island responses to elevated sea level by examining additional physical processes that enable islands to build vertically. The magnitude and temporal and spatial dimensions of vertical aggradation of islands are explored and implications for future persistence discussed.

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REEF-BUILDING CORALS AS A NATURAL MODEL FOR EVOLUTIONARY TRANSITIONS IN SYMBIONT TRANSMISSION MODE (Abstract ID: 28094)

Symbiosis has played a fundamental role in the evolution of life, and in the case of reef-building corals, constitutes the foundation of one of the most biodiverse and productive ecosystems on the planet. However, surprisingly little is known about how inter-species mutualisms evolve from cooperative partnerships to integrated organisms, though symbiont transmission mode is predicted to be important. A transition from horizontal (symbionts sourced from the environment) to vertical (direct transfer from parent to offspring) transmission aligns the reproductive interests of partners and should optimize resource sharing to maximize whole organism fitness. We quantified resource sharing and evaluated changes in fitness between horizontal and vertical transmitters using three pairs of closely related coral species with different strategies. Two out of three vertical transmitters exhibited phenotypes consistent with predictions: both Porites lobata and Montipora aequituberculata exhibited higher growth and enhanced bleaching tolerance compared to their horizontally transmitting counterparts. Surprisingly, all hosts and symbionts continued to share carbon in spite of thermal stress, suggesting that a breakdown in host-symbiont cooperation is a consequence rather than a cause of coral bleaching. We discuss possible explanations for trait variation among vertical transmitters and argue that future investigations using this framework could provide novel insights into the coral-algal symbiosis.

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REEF CARBONATE BUDGET RESPONSES TO CLIMATE CHANGE AND THE USE OF CORALLINE ALGAE AS A RESILIENCE INDICATOR FOR OCEAN ACIDIFICATION (Abstract ID: 28963)

Ocean acidification (and warming) are known to negatively influence calcification rates of marine organisms, with crustose coralline algae (CCA) – which use high-mg calcite to

build skeletons – believed to be particularly vulnerable to changes in seawater chemistry. Despite this, little is known about 'normal' calcification rates of corallines along the Great Barrier Reef (GBR), and their relative contribution to reef structural growth. Our project set out to describe variability in CCA calcification rate, spatially (along the length and breadth of the GBR) and temporally (between seasons). Determining in situ calcification rates provided a baseline for future monitoring efforts aimed specifically at tracking climate change (ocean acidification) impacts on Australian reefs. We augmented our CCA calcification data by placing it into the wider context of reef structural growth, developing the first comprehensive set of census-based coral reef carbonate budgets for the GBR. Reef carbonate budgets, which take into account both biomineralisation (by CCA and corals) and bioerosion processes, describe the ability of a reef to maintain both their structural integrity and vertical reef growth capacity. Data on each reef's carbonate budget status, as well as providing an assessment of reef health, will be further used to inform predictive models that will examine the point of reef functional collapse under future climate scenarios. As CCA play key roles in reef stabilisation and recovery, documenting natural variability in coralline calcification rates in the context of reef carbonate budgets will support research into environmental thresholds for healthy reef structural growth.
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THE ROLE OF TABULAR STRUCTURE IN THE ECOLOGY OF LARGE REEF FISHES (Abstract ID: 27788)

Although prior studies had hypothesised that declines in the abundance and diversity of large reef fishes might be seen following the loss of tabular structures, no studies had experimentally demonstrated this relationship. We therefore examined this outcome by excluding access of large reef fishes to the understory of tabular structures. The exclusion of large reef fishes from tabular structures using mesh wire had a significant effect on the distribution of large reef fishes, even though these structures only constituted a small fraction (4%) of the benthic cover. Reduction in the availability of tabular structures at this spatial scale (200 m2) shifted activity spaces of fishes away from these localities. To examine why some species of large reef fishes demonstrate such a strong attachment to tabular structure, we sought to test two hypotheses to explain sheltering behaviour: avoidance of predation or avoidance of solar irradiance. Patterns of shelter use offered minimal evidence in support of the predation avoidance hypothesis, with usage of tabular structures being low during the sunset period when predators of large reef fishes were likely to be most active. However, tabular structure usage reached a peak during the middle of the day when incident solar irradiance would reach its zenith. As such, the data suggest that large reef fishes are primarily sheltering to protect themselves from harmful UV irradiance. Given the significant costs of producing UV-blocking mycosporine-like amino acids, fishes may achieve considerable energetic savings by sheltering.

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MARINE PROTECTED AREA PRIORITY SITES FOR FISHERIES AND BIODIVERSITY OBJECTIVES IN THE CENTRAL SAUDI ARABIAN RED SEA (Abstract ID: 28607)

Spatial prioritization is an important step for making sound decisions regarding sustainable management of marine resources. Ideally, such management should protect biodiversity while also achieving sustainable fisheries objectives, but these two contrasting objectives are rarely combined in systematic conservation planning. Here, we prioritize reefs for inclusion in local marine protected area (MPA) networks near Thuwal in the central Saudi Arabian Red Sea, aiming to achieve either fisheries or biodiversity objectives. We then compare the outputs of these spatial prioritization exercises. Within each type of objective, minimum and maximum recommended levels of protection (up to 10 and 30% of available resources, respectively) were considered, leading to a total of four scenarios. The scenarios for fisheries objectives integrated spatial patterns of the abundances of 11 commercially targeted fish species, while those for biodiversity integrated 7 fish species and 5 benthic categories that are endemic and/or representative of different local reef communities. Results showed considerable spatial overlap between MPAs produced for fisheries and those produced for biodiversity objectives; however, MPAs for fisheries were generally larger, and thus, likely to be more expensive. Overall, results suggest that implementing a local MPA network that can achieve both fisheries and biodiversity objectives simultaneously may be possible in the presence of adequate species information.

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WHEN DO ADULT REEF FISHES DIE? (Abstract ID: 28956)

Mortality is considered to be critically important in shaping reef fish communities, however, we currently know remarkably little about the nature of mortality in adult coral reef fishes. Mortality on coral reefs is intrinsically linked with predation, with most evidence suggesting that key predators are usually on the hunt during dawn and dusk. We tested this 'crepuscular predation' hypothesis using passive acoustic telemetry movement data to determine the time of day of potential mortality events of adult herbivorous reef fishes. Furthermore, we identified five types of potential mortality events based on the nature of change in signal detections from tagged fishes. We found that the majority of the potential mortality events were characterised by an abrupt stop in detections, possibly as a result of a large, mobile predators such as a carangids or reef sharks. Mortality in adult herbivorous reef fishes is higher during the day than previously expected. The time of day of the potential mortality events suggest that predation was highest during the day and crepuscular periods, and lowest at night, offering only partial support for the crepuscular predation hypothesis. Visually-oriented, diurnal and crepuscular predators appear to be more important than their nocturnal counterparts in terms of predation on adult reef fishes. By revealing the timing of potential mortality events, passive acoustic telemetry may offer an important new tool for investigating the nature of predation on coral reefs.

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LONG-TERM MONITORING OF CORAL HEALTH IN BOCAS DEL TORO, PANAMA FOLLOWING THE 2005, 2010, AND 2015 MASS BLEACHING EVENTS (Abstract ID: 28247)

Coral reefs are declining worldwide due to climate change and other local and global environmental stressors. However, most research on coral reef health does not track the corals for sufficient time after a disturbance to determine the long-term effects. For this project, we observed the bleaching response, mortality, and recovery of over 300 tagged coral colonies in Bocas del Toro, Panama by photographing them approximately annually between 2005 and 2015. There was a Caribbean-wide mass bleaching event in 2005, followed by additional bleaching events in 2010 and 2015. We measured the areas of bleached, partially bleached, and live and dead tissue on individual tagged corals of 7 dominant Caribbean reef species using image segmentation to calculate growth and decline rates. We found that there were significant differences between species and that by 2013, all corals had declined in live area. Moreover, field observations from 2015 and preliminary analyses show that previously resistant species such as *Siderastrea siderea*were more affected by the 2015 bleaching event than previously vulnerable species such as *Stephanocoenia michelini* and *Orbicella franksi*. This indicates that coral recovery is a complex process that is likely dependent on multiple factors; therefore, time series are important because they allow us to consider recovery on a longer time scale. By continuing to monitor bleaching and assessing reef health, we can better understand how coral reefs will respond to a warmer future and try to develop effective management strategies.

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SISTER SANCTUARIES LINK CORAL REEF SCIENCE AND STEWARDSHIP IN CUBA AND THE U.S. TO ENHANCE PLACE-BASED MANAGEMENT (Abstract ID: 28181)

The currents that flow from the Caribbean through the Gulf of Mexico and into the Atlantic physically connect the coral reefs of Cuba and the SE U.S. Collaboration in marine science and management between Cuba and the U.S. is therefore essential to strengthening and protecting the ecological integrity of coral reefs in the Gulf of Mexico and South Florida. As part of the cooperation on MPA science, management and education programs recently established by Cuba and the U.S., joint marine conservation and research programs at Guanahacabibes National Park's Banco de San Antonio and Flower Garden Banks National Marine Sanctuary are being designed. Flower Garden Banks National

Marine Sanctuary has comparable physical and biological features to the coral reefs at Banco de San Antonio. The sister sanctuary designation allows direct evaluation of the influences on ecosystem functions and changes at the two sites. It also allows the U.S. and Cuba to share their technical expertise in characterizing the physical and biological features within the sister sites, understanding the migratory and reproductive connections of species between the sites, investigating the mechanisms that spread invasive species, pathogens and pollution in the region, and evaluating how human activities are impacting marine resources in both countries. These and other programs developed in this sister sanctuary relationship are establishing unprecedented cooperation between the U.S. and Cuba at a time when their marine resources and societies urgently need it.

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CORAL HEALTH & DISEASE IN URBAN VERSUS RURAL AREAS OF TIMOR-LESTE (Abstract ID: 29046 | Poster ID: 157)

Coral disease and other signs of compromised health (i.e. macroalgal overgrowth, invertebrate overgrowth etc.) are expected to be an increasing threat to coral reefs in a warming and acidifying ocean. Timor-Leste became a sovereign state in 2002 and is located in the Lesser Sunda Islands in the southern Indo-Pacific. Line intercept transects for benthic cover and 15 x 2 m belt transects quantifying coral health and disease were conducted in November 2015 at two urban and two rural sites and revealed varying levels of coral cover and low levels of disease. Beloi Barrier Reef, a rural site, in the channel 25 km off the coast had the highest coral cover and diversity compared to the remaining rural and urban sites onshore, but also had the highest level of coral disease at 1.6%; however, the sites had higher levels of compromised health such as tunicate overgrowth and flatworm infestation. Additional sediment and macroalgal samples were collected at all sites for analysis of heavy metals and stable isotope analysis respectively to determine any potential links with coral disease and compromised health.
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JEJU ISLAND, SOUTH KOREA SOFT CORAL COMMUNITY STRUCTURE ANALYSIS (Abstract ID: 29331 | Poster ID: 65)

Anthozoa recorded that inhabit total seven Order, 19 Family, 43 species in Munseom, Beomseom, train rocks, Jeju-do, Korea to march and june in 2011. Munseom recorded that 27 species and 30.8% mean coverage to high diversity and dominant rate in june. Beomseom and train rocks almost similar leveled that each species number(23 and 22 species) and dominant rate(21.2%, 25.4%). Anaysis of similarity of anthozoa between communities that Beomseom and train rocks had the highest similarity. Munseom and Beomseom had the lowest similarity. But statistically three areas appeared a similar community structure. This study compare with Seoul National University (2009) study of survey results of research region(munseom, beomseom, trains rocks) that were almost the same level species number, mean coverage, diversity index. Anthozoa dominant species composition showed a similar trend. and recently anthozoa community is expected that stable populations are being maintained. Legal management species of this research appeare in total seven species Myriopathes lata, Dendronephthya suensoni, Dendrophthya putteri Kukenthal, Euplexaura crassa, Dendronephthya castanea, Dendronephthya mollis, Tubastraea coccinea.

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FILLING THE GAPS: IMPUTATION OF CORAL TRAIT DATABASE AND FUNCTIONAL BIOGEOGRAPHY OF CORALS (Abstract ID: 28289)

Variability in functional traits and their responses to environmental filters provide raw material for a variety of research areas from population and community ecology to conservation. However, compilation of trait information on a global scale requires prohibitively extensive fieldwork. Consequently, global trait databases for many organisms, including corals, remain largely sparse, and understanding the spatial distribution of corals' functional diversity is challenging. A common practice in other taxonomic groups for missing values is to disregard the missing values and characterise functional groups only using the known values despite the fact that such reduction in datasets may result in erroneous or biased projections. Here we show that missing values in global trait databases can be imputed using statistical tools. Functional biogeography of corals based on the resultant comprehensive dataset reveals spatial heterogeneity in trait combinations, and the correlation between biodiversity indicators (species richness and phylogenetic diversity metrics) and functional diversity indices (functional richness, evenness, and divergence).

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TERRESTRIAL POLLUTION VERSUS GLOBAL WARMING: WHAT DRIVES CORAL ANNUAL EXTENSION IN THE ANTHROPOCENE ERA? - A CASE STUDY IN CHUUK LAGOON, MICRONESIA - (Abstract ID: 29228 | Poster ID: 442)

Terrestrial pollution and CO2-driven global warming are main threats to coral reefs ecosystems. Previous studies revealed the contrasting responses of reef building coral species to human-led changes. Increased sea surface temperature (SST) reduced coral annual extension in the Red Sea, whereas, terrestrial pollution increased extension in Indonesia. These two concurrent threats raise some questions about coral annual extension in the Anthropocene. Coral reefs in Chuuk lagoon have suffered from high anthropogenic impacts through the WWII and subsequent population growth, additionally, the SST increased by about 0.5 °C over the same period. To assess the relative importance of these two factors in coral annual extension, we collected two coral cores of Porites sp. at Newman and Nepukos which are located at Weno island in Chuuk lagoon, Federated States of Micronesia. Age estimation based on band counts of x-radiograph indicated the first core encompasses the time-period 1938-2013 and the second core is estimated to include the entire 20th century. According to correlation analyses, coral annual extension showed no correlation with SST and population density, however, significantly correlated with precipitation on the most recent half of the record. While the second core is still being analyzed, the preliminary results indicate increased human population and concomitant deforestation caused an influx of terrestrial pollutants and subsequently affect coral annual extension rather than global warming nearshore reef.

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NOAA'S NATIONAL CORAL REEF MONITORING PROGRAM: INTEGRATED ECOSYSTEM MONITORING AND REPORTING IN U.S. CORAL REEF AREAS TO INFORM CONSERVATION AND MANAGEMENT (Abstract ID: 29448)

The National Oceanic Atmospheric Administration's Coral Reef Conservation Program (CRCP) strives to protect, conserve, and restore coral reef resources by maintaining healthy ecosystem function. Since 2013, CRCP has supported the National Coral Reef Monitoring Program (NCRMP) to collect biological, physical, and socioeconomic data

throughout the U.S. Pacific, Atlantic, and Caribbean coral reef areas. The overarching goal of this effort is to collect the information needed to gauge the changing conditions of U.S. coral reef ecosystems and support well-informed ecosystem-based conservation and management. NCRMP is a long-term approach to provide an ecosystem prospective via monitoring benthic, fish, climate, and socioeconomic variables in a consistent and integrated manner, to provide information supporting NOAA and our State, Territorial, and other Federal partners efforts to more effectively manage and conserve our nation's coral reefs. We will present on the development and implementation of the general themes and core indicators of NCRMP, as well as the partnership with the University of Maryland Center for Environmental Science, to develop pilot status and trends reports (Report Cards) synthesizing the monitoring data on coral reef ecosystems, including benthic, fish, climate, and socioeconomic data streams.

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PROTECTED AREAS NETWORK (PAN) – NATIONAL SYSTEM FOR THE PROTECTION OF THE CORAL REEF ECOSYSTEMS IN PALAU (Abstract ID: 28772)

The Protected Area Network (PAN) is a national mechanism to protect the critical biodiversity and ecosystems in Palau. The PAN was established in 2003 under the national low for enhancing the state governments to conserve the national network of protected areas. State governments may apply for membership to register their protected areas as PAN sites through the PAN Office that handle all the activities regarding to PAN. PAN Office provides technical resources, advices, guidelines and trainings to the members for better management of the PAN sites. This national system also includes Green Fees, a fee paid by all visitors leaving Palau. These fees go into a restricted PAN Fund, which is used for management of PAN member sites. A five year Science and Technology Research Partnership for Sustainable Development (SATREPS) project has been conducted for the Sustainable Management of Coral Reef and Island Ecosystems: Responding to the Threat of Climate Change since 2013 to provide scientific data and information for conservation of Palau's Island ecosystems focusing on climate changes, biodiversity conservation and protected area management. The project has also supported capacity building for state governments on monitoring and management of the PAN sites to enhance conservation of the biodiversity of entire islands ecosystems of Palau. This presentation shows the processes and mechanisms of the project to support capacity building of PAN.

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INVASIVE MARINE PREDATOR ALTERS COMPETITION BETWEEN NATIVE CORAL-REEF FISHES (Abstract ID: 28866)

Our understanding about the mechanistic ability of invasive predators to influence native communities and ecosystems is limited. We tested whether the invasive Pacific red lionfish (*Pterois volitans*) alters interspecific competition between native species on Atlantic reefs: fairy and blackcap basslets (*Gramma loreto* and *Gramma melacara*). We conducted a manipulative experiment in The Bahamas to measure the response of each prey species in local populations under isolated reef ledges in both the presence and absence of its competitor cross-factored with the presence and absence of the invasive predator. Lionfish significantly affected the density of juvenile fairy basslet through time ($p=0.012$), causing substantial declines in prey by the sixth week of manipulation. Lionfish indirectly enhanced the feeding position and individual growth rate of juvenile blackcap basslet: these fish exhibited shifts towards coveted feeding positions and higher growth rates that were comparable to the response in populations where fairy basslet had been experimentally removed. Additionally, the effects of competition on these parameters were significant in low-lionfish reefs (position: $p=0.043$; growth: $p=0.046$), but were not significant in high-lionfish reefs (position: $p=0.201$; growth: $p=0.680$). Lionfish did not alter any effects of competition on fairy basslet. These results indicate that predation by invasive lionfish differentially affects fairy basslet, which tips the balance of competition from symmetrical to asymmetrical in favor of blackcap basslet.

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LARVAL BEHAVIOR AND LONGEVITY OF FISHES INFLUENCES THE GENETIC RESILIENCE OF REEF-BASED POPULATIONS (Abstract ID: 27863)

The persistence of reef fish populations depends on reproductive output, larval behaviour and survival, pathways of connectivity and postsettlement processes. A surprisingly high percentage of many fishes recruit to their natal reefs and recent studies have indicated that connectivity may be so limited that genetic differences may persist at small spatial scales (kilometres to tens of kilometres). Key elements of such differences include larval dispersal and behaviour and post settlement longevity. We show that larval behaviour that can assist in the persistence of genotypes while very short lives, for some common fishes, could weaken genetic resilience.

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REPRODUCTIVE BIOLOGY OF THE BRAIN CORAL, PLATYGYRA SINENSIS AT MU KO SAMAE SAN, CHON BURI PROVINCE IN THE UPPER GULF OF THAILAND (Abstract ID: 29709 | Poster ID: 167)

Platygyra sinensis is one of the most common species in Mu Ko Samae San, Chon Buri Province, the upper Gulf of Thailand. In this study, gamete development and post-fertilization development of the brain coral Platygyra sinensis, were investigated. From the field observations, the results showed that the development of gametes started from February to March of each year, and the spawning occurred later from March to April within 4 to 5 days after the full moon. After the spawning, gametes were collected and brought back to the coral hatchery for fertilization. Fertilization rates of the gametes in the coral hatchery were more than 95%, and the settlement rates of planulae varied from 15 to 30%. This finding can be a baseline data for further use of sexual propagation of corals in Thailand.

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TEMPORAL PATTERNS OF GENE EXPRESSION IN RESPONSE TO HEAT AND SALINITY STRESS IN *PLATYGYRA DAEDALEA* FROM THE PERSIAN GULF (Abstract ID: 29774)

Scleractinian corals are severely threatened by rising ocean temperatures and some coral populations possess heritable genetic variation in thermal tolerance, providing potential for adaptation to climate change. High seawater temperatures (reaching 36°C) and salinity (up to 45 ppt) in the Persian/Arabian Gulf have likely selected for environmental stress tolerance in the local populations, presenting a unique resource for the study of corals' adaptive potential in a warming climate. To investigate thermal tolerance phenotypes in these populations, we focused on aposymbiotic larval stages of *Platygyra daedalea*. Thermal tolerance (survival during heat stress) was measured in 55 controlled crosses generated from 13 parental colonies. We documented moderate genetic variation in thermal tolerance ($h2=0.33$), and identified families with contrasting tolerance phenotypes. To investigate the functional basis for these differences, larvae were exposed to factorial combinations of elevated temperature and salinity. Transcriptional responses were examined using RNA-Seq, which revealed greater upregulation of putative stress response genes in susceptible than resistant families. To investigate the dynamics of gene expression more directly, we conducted 10 additional crosses in a subsequent season and profiled changes in gene expression during a time-course thermal stress experiment. This study provides insights into the mechanisms through which stress tolerant corals persist in the Gulf, and ultimately into possible mechanisms through which corals may adapt to climate change.

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PHYLOGENETIC RELATIONSHIPS BETWEEN ZOANTHARIAN *EPIZOANTHUS* SPP. (ANTHOZOA: HEXACORALLIA) AND HOST *EUNICE* SPP. TUBE WORMS (EUNICIDAE) (Abstract ID: 28015 | Poster ID: 82)

Examples of co-speciation between hosts and their associates based on phylogenetic molecular analyses have become common in recent years. However, there are few marine invertebrate examples due to taxonomic uncertainty in many taxa hindering such analyses. In this research, we investigated the phylogenetic relationships among three species of epibiotic zoantharians (*Epizoanthus* spp.) and their host eunicid worms (*Eunice* spp.). Freshly collected and museum Pacific Ocean specimens of *Eunice* spp. with *Epizoanthus* colonies on their zig-zag tubes were examined. Molecular and morphological analyses were conducted to estimate phylogenetic congruence between the zoantharians and eunicid worms. The phylogenetic relationships were conducted using sequences from multiple molecular markers (nuclear 18S ribosomal DNA and internal transcribed spacer region of ribosomal DNA; mitochondrial 16S ribosomal DNA and cytochrome oxidase subunit I) for both hosts and epibionts. Phylogenetic congruence was tested by topology-based, distance-based, and data-based methods. The combined data set

indicates co-speciation and duplication between*Epizoanthus* species and eunicid worms. In this presentation, we discuss the phylogenetic relationships between *Epizoanthus* and *Eunice*, showing the existence of previously unknown cryptic diversity.
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SPECIES AND GENOTYPE DISTIBUTION OF POCILLOPORA DAMICORNIS-LIKE CORAL ACROSS SUBTROPICAL TO TEMPERATE REGION IN JAPAN (Abstract ID: 29997 | Poster ID: 51)

Rising sea surface temperature is expected to have impacts on distribution of corals. Therefore it is necessary to study the current distribution of species and genetic structure for future prediction of coral reef ecosystem. We investigated the distribution of *Pocillopora damicornis* and *P. acuta*, which had long been treated as a junior synonym of *P. damicornis* across subtropical to temperate region of Japan. Both species were distinguished by genetic analysis based on the mitochondrial open reading frame (ORF) sequences although morphological identification is difficult especially in field. We found that *P. acuta* distributes only subtropical region (northern limit, 30°28'N), while *P. damicornis* distributes in all regions but is dominant in temperate region. Similar distribution of both species has been observed in other region of Indo-Pacific. We also found two haplotypes in Japanese *P. damicornis*; one of them is the major one widely shared in the tropical Pacific reefs, and the other one is a novel one that is dominated in the temperate region. We obtained similar result by genetic analysis using polymorphic nuclear microsatellite markers that showed clear genetic break between subtropical and temperate regions. Such limited gene flow among the regions implies the adaptation of the populations to the peculiar environment in each region. Distribution of genotypes of *P. damicornis* appears to correlate with sea surface temperature in winter.

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FAILURE TO SPAWN: A SELF-CRITIQUE OF PARTNERSHIP SUCCESSES AND SINKHOLES (Abstract ID: 29537)

It's easy to take a victory lap when effective partnerships lead to successful implementation; it's less fun to admit when these efforts fail to ignite sustainable, long-term action. Why does one watershed or marine conservation area get more traction than another? What absentee partner is critical to sustaining implementation enthusiasm? Who is maintaining those restoration projects? Where did that management plan go? After a decade of providing technical assistance, training, and partnership support for addressing land-based sources of pollution in the US coral reef jurisdictions, we have had plenty of time to reflect on the factors contributing to our successes and sinkholes. Through live, interactive audience polling, this session will encourage you to critique your own partnerships and projects and identify mechanisms for improving your chances of long-term success. Lessons-learned and laughter, not finger-pointing and criticism, will help to remind us that there is always room for improvement, particularly when our goal of coral conservation is so high.

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HYPERTHERMAL STRESS ALTERS TRANSCRIPTOMIC RESPONSE OF CORAL LARVAE AT THE ONSET OF SYMBIOSIS (Abstract ID: 29494)

Cnidarian-dinoflagellate partnerships collapse under prolonged thermal stress associated with climate change. We are beginning to understand the physiological and molecular consequences of bleaching events on host-symbiont associations in adult corals; however, few studies have addressed the effects of thermal stress during onset of symbiosis in coral larvae. The capacity of larvae to buffer climate-induced stress while undergoing symbiosis comes with physiological trade-offs altering behavior, development, settlement and survivorship. Understanding the mechanisms that underlie the formation of symbiosis during early developmental stages is critical to predicting coral resilience and resistance to stress and overall reef ecosystem health in the future. Here we examined the effects of both thermal stress and onset of symbiosis together on symbiont colonization, survival, and host global gene expression in *Acropora digitifera* larvae. The combined stress increased mortality, decreased symbiont colonization by half and algal density by 98.5% after two weeks. Using RNASeq, we identified 232 differentially expressed genes with the interaction of olonization and thermal stress. The combination of events changed expression of genes linked to immune, cytoskeletal, oxidative stress and lipid metabolism pathways. In addition, we used co-expression networks to isolate temperature and symbiosis transcriptional patterns. These findings expand our understanding of how the physical environment, biotic pressures and molecular coral stress-response mediate pre-settlement events in corals.

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FROM REEF TO TABLE: SOCIAL AND ECOLOGICAL FACTORS AFFECTING CORAL REEF FISHERIES, ARTISANAL SEAFOOD SUPPLY CHAINS, AND SEAFOOD SECURITY (Abstract ID: 28249)

Ocean and coastal ecosystems provide critical fisheries, coastal protection, and cultural benefits to communities worldwide, but these services are diminishing due to local and global threats. In response, place-based strategies involve communities and resource users in management have proliferated. Here, we present a transferable community-based approach to assess the social and ecological factors affecting resource sustainability and food security in a small-scale, coral reef fishery. Our results show that this small-scale fishery provides large-scale benefits to communities, including 7,353 ± 1547 kg yr-1 (mean ± SE) of seafood per year, equating to >30,000 meals with an economic value of $78,432. The vast majority of the catch is used for subsistence, contributing to community food security: 58% is kept, 33.5% is given away, and 8.5% is sold. Our spatial analysis assesses the geographic distribution of community beneficiaries from the fishery (the "food shed" for the fishery), and we document that 20% of seafood procured from the fishery is used for sociocultural events that are important for social cohesion. This approach provides a method for assessing social, economic, and cultural values provided by small-scale food systems, as well as important contributions to food security, with significant implications for conservation and management. This interdisciplinary effort aims to demonstrate a transferable participatory research approach useful for resource-dependent communities as they cope with socioeconomic, cultural, and environmental change.
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0123856

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IDENTIFICATION OF PRIORITIES FOR THE EXPANSION OF THE MARINE PROTECTED AREA ESTATE OF REPUBLIC OF SEYCHELLES (INDIAN OCEAN) (Abstract ID: 29514 | Poster ID: 527)

The Republic of Seychelles is responsible for a vast Exclusive Economic Zone (EEZ) and 155 islands covering 1.35 million km$^2$. The Government of Seychelles (GoS) has declared a large number of protected areas (PAs). The existing marine PA estate only covers <1% of the EEZ. In 2011, the GoS made a bold new commitment to expand the PA estate beyond the Aichi Targets set by the Convention on Biological Diversity - Strategic Plan for Biodiversity 2011–2020. The goal set by GoS was 50% of all terrestrial areas, and 30% of the Seychelles EEZ, 15% of which would be identified as 'no-take' areas. The GoS recognised the need to assess the existing estate and the potential benefit of using spatial decision-support tools to identify priority gaps for the future expansion of the national network. With the support of a GoS-UNDP-GEF project, the Seychelles Systematic Conservation Planning (SEY-SCP) process was launched. The SEY-SCP process established new procedures to promote the sharing of data, which facilitated the release and compilation of previously unavailable datasets from national, regional and international sources. Through a series of workshops and MARXAN modelling of these datasets, a provisional set of PAs was delineated for further consultation. These included larger areas proposed as "Sustainable Use" areas, which are closely compatible with the existing "Fisheries Exclusion Zones" that subdivide national and international fishing grounds. The key steps in the SEY-SCP process will be presented with the main results and recommended follow-up actions.
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LONG TERM CHANGES IN THE STATUS OF THE CORAL REEF OF ALDABRA ATOLL (SEYCHELLES): A GLOBALLY SIGNIFICANT CORAL REEF OBSERVATORY (Abstract ID: 29804)

Aldabra, the world's second largest atoll, situated away from the main populated Seychelles islands, provides an ideal benchmark for assessing long-term changes in coral reef health. This remote atoll only narrowly avoided becoming a military base in the 1960's due to an intervention by the Royal Society and David Stoddart. Managed by the Seychelles Islands Foundation (SIF) since independence, the atoll was inscribed as a UNESCO World Heritage (WH) site in 1982 and is still one of only two marine WH sites in the entire Indian Ocean. Marine research has been limited compared to terrestrial studies due to operational challenges. After the mass coral bleaching event in 1997/1998, an external group of researchers established the Aldabra Monitoring Programme (AMP) to help SIF assess the condition of the reefs. The AMP completed surveys in 1999, 2001- 2006 and 2008. In 2012, SIF recognised the need to build internal capacity for marine monitoring. With support from a GOS-UNDP-GEF funded project, the protocol was revised to create a more practical scalable solution: existing sites at 10m and 20m depth were resurveyed and repositioned to 15m and 5m and new video and photographic survey technologies were introduced for benthos and fish. The results of the new programme demonstrate the recovery of the reef since 1998, but also highlight new concerns, including the presence of *Terpios hoshinota*, the furthest western reported occurrence of this coral-killing sponge in the Indian Ocean, which together with the anticipated coral bleaching in 2016 pose a threat to this legacy site.
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THE TIMELINE OF THERMAL ACCLIMATIZATION IN AMERICAN SAMOAN CORALS: HOW LONG DOES IT TAKE TO GAIN BLEACHING RESISTANCE? (Abstract ID: 28559)

Corals native to variable thermal environments often resist bleaching temperatures and survive exposures that typically bleach conspecifics from cooler environments; providing promising evidence for the persistence of reefs under projected global climate change. This bleaching resistance is attributed to acclamatory or adaptive conditioning to brief, but frequent high water temperatures. Acclimatization plays an important role in modifying thermal thresholds and has been observed within 1 week and up to 2 years. However, it is not known what acclimatory potential happens during the first year and how many species are capable of acclimation gains in bleaching resistance. This study transplanted populations of Porites lobata and Goniastrea retiformis from three contrasting backreef environments in Ofu Island, American Samoa into a highly variable pool known to elicit increased bleaching tolerance. Following one week and six months, transplanted and native coral nubbins were subjected to a controlled thermal exposure. Physiological responses to bleaching – zooxanthellae density, chlorophyll a, and photosynthetic efficiency – were quantified to elucidate the level of bleaching resistance attributed to acclimatization. One week of conditioning was not enough time to elicit enhanced bleaching resistance for these species, in contrast to previous studies using Acropora. Comparative results following 6 months of exposure are being collected and will be presented. This study provides a significant expansion of previous work and critical insight into coral acclimatization dynamics.

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POTENTIAL ROLE OF LARVAL CONNECTIVITY IN CORAL TEMPERATURE THRESHOLDS (Abstract ID: 28407)

The sensitivity of corals to elevated temperature depends on their acclimation and adaptation to the local maximum temperature regime. Through larval dispersal, however, coral populations can receive larvae from regions that are significantly warmer or colder. If these exogenous larvae carry genetic- based tolerances to colder or warmer temperatures, then the thermal sensitivity of the receiving population may be lower or higher, respectively. Using a high-resolution Regional Ocean Modeling System (ROMS) configuration for the Coral Triangle region, we quantify the potential role of connectivity in determining the thermal stress threshold (TST) of a typical broadcast spawner. The model results suggest that even with a pelagic larval dispersal period of only 10 days, many reefs receive larvae from reefs that are significantly warmer or cooler than the local temperature. This has important implications for conservation planning, because connectivity may allow some reefs to have an inherited heat tolerance that is higher or lower than would be predicted based on local conditions alone.
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INTEGRATING CELLULAR PHYSIOLOGY, RECIPROCAL TRANSPLANTS AND REEF BIOGEOCHEMISTRY TO DECIPHER THE MECHANISMS FOR CORAL CALCIFICATION AND PHOTOSYNTHESIS. (Abstract ID: 29977)

There is growing concern about the future of coral reefs and the impact of anthropogenic stressors including eutrophication, ocean acidification, and warming. However, the lack of knowledge of fundamental coral cellular mechanisms precludes our ability to understand and predict general and species-specific responses to stress. Conversely, results from controlled laboratory experiments are not necessarily relevant for corals in the field, where environmental conditions may change dramatically from one reef site to the next, limiting our ability to implement appropriate management decisions. Using an integrated set of field studies, including sampling of corals from different environments and reciprocal transplants between sites and depths, with manipulative single stressor aquarium studies, immunohistochemistry, and ecosystem level biogeochemical studies, we are trying to better understand mechanisms underlying coral calcification and photosynthesis. We will present results from studies in Bocas del Toro, Panama, with support from the NSF. The overall approach was to study recently discovered cellular mechanisms related to calcification and photosynthesis in three coral species, Orbicella franksi (Robusta), Acropora cervicornis (Complexa), and Porites furcata (Complexa) at two field sites with different environmental conditions, as well as in aquarium studies. The goal is to assess the relevance of these cellular mechanisms in nature and to identify biomarkers of coral physiology that can eventually be used to monitor and predict responses to stress.
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ENVIRONMENTAL METABOLOMICS – A NEW DIAGNOSTIC TOOL FOR CORAL REEF ECOSYSTEM ASSESSMENT AND MONITORING? (Abstract ID: 30070)

Worldwide, coral reefs are under increasing pressure from a variety of environmental and anthropogenic stresses, creating a need to establish efficient and accurate methods to monitor reef health. Metabolomics, the comprehensive measurement of all metabolites and low-molecular-weight molecules in an organism, provides an opportunity to assess the effects of environmental change at an extremely fine scale. This should lead to the identification of suitable bio-indicators for use in coral reef ecosystem monitoring. Currently, we are in a developmental phase, where technologies are being refined, and baseline knowledge on a variety of metabolomes is being acquired. We characterized metabolic profiles of Stylopohora pistillata, collected from three geographically disjoined locations in the GBR that differ in water quality. Tissue was analyzed by preparing acetone/methanol extracts for Liquid Chromatography Mass Spectrometry. A Random Forest analysis indicated significant differentiation of metabolic profiles in relation to sampling location, and also identified diagnostic metabolites. Differences among regions were quantified via a hierarchical Bayesian model. This talk will summarize the results of a comprehensive environmental metabolomics approach and evaluate the effects of water quality on the metabolic profiles of S. pistillata. Using results and lessons learned in this study, we critically evaluate the potential of environmental metabolomics as a new monitoring technology for assessing the health of coral reefs. In particular, we highlight issues concerning sample collection, metabolite identification, and statistical analyses.

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HOMOLOGS TO HUMAN CANCER GENES ASSOCIATED WITH CORAL GROWTH ANOMALIES (Abstract ID: 28448)

Scleractinian disease outbreaks can be hugely detrimental to coral reef ecosystems and are only predicted to increase in frequency and severity under long-term global climate change. Despite great advances in our knowledge of coral diseases since their discovery over 50 years ago, disease causation is still unknown or poorly understood for many diseases due to their complex multifactorial etiologies. It is also clear that not all individuals from the same species are afflicted when there is a disease outbreak, suggesting that both environmental and biological factors will determine the long-term outcome of a population. For the first time, next-generation technologies such as restriction site-

associated DNA sequencing (RAD-seq) provide the tools to examine the genome from non-model organisms, like scleractinian corals, relatively easily and cheaply. Here we use ezRAD and Seanome (a pipeline developed to analyze ezRAD data) to screen the single nucleotide polymorphisms (SNPs) between both healthy and diseased (growth anomalies) Acropora cytherea colonies from Palmyra Atoll, Central Pacific. We found consistent genetic differences between colonies with and without growth anomalies. In addition, gene ontology (GO) annotation of the enriched variants in the diseased colonies highlighted a number of regions that were linked to important functional components found in human cancers. This is the first instance genetically linking hyperplasias in humans to the more basal cnidarians, indicating that this process is potentially conserved and fundamental in metazoans.
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PIGGYBACK-THE-WINNER: ECOSYSTEM AND EVOLUTIONARY EFFECTS OF VIRAL LYTIC TO LYSOGENIC SWITCHES ON CORAL REEFS (Abstract ID: 28882)

Viruses and protists can control microbial communities through density-dependent predation. This top-down dynamic inhibits microbial growth, at odds with increasing microbial densities observed on degraded coral reefs. Viral and microbial abundances on coral reefs show a decline in the ratio of viruses to hosts, consistent with suppressed viral predation at high host density. Bioinformatic analysis of viral communities explained this deviation from density-dependence, showing that high host densities are associated with lysogenic dynamics - where viruses integrate into host genomes - rather than lytic predation. Lysogenic viral communities carry increased levels of pathogenicity genes, possibly granting their hosts the ability to evade protist predators. Viruses therefore appear to become parasitic when predation is favored by density- and frequency-dependent Kill-the-Winner dynamics, a model we term Piggyback-the-Winner (PtW). PtW dynamics likely facilitate increasing microbial densities as non-lytic activity is favoured at high host density and by conferring on hosts broad-spectrum immunity to viral infection as well as viral-encoded functions. The resulting lineages with integrated viruses are ecologically and evolutionary divergent from their non-lysogen conspecifics and experience different selection pressures. This may explain how degraded ecosystems that have transitioned towards PtW rather than more resilient Kill-the-Winner dynamics are dominated by few, unstable, pathogenic bacterial lineages that can survive at high densities with protective integrated viruses.

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CORAL REEF ECOSYSTEM PROPAGULE RETENTION AND EXPORT UNDER SCENARIOS OF CLIMATE CHANGE (2006-2100) (Abstract ID: 30060)

Propagule transport within and between a global circumtropical array of coral reef habitats (derived from the WRI Reefs at Risk Revisited global database) was investigated using flow-fields from CMIP5 Earth System Models ESM2G RCP4.5 and RCP8.5 developed by the USA NOAA Geophysical Fluid Dynamics Laboratory coupled with Lagrangian particle transport modeling. These models allowed long-term projection of planktonic egg and larval connectivity out to year 2100 using ocean currents realized under plausible scenarios of climate change. Temporal and spatial patterns of propagule connectivity were identified using generalized additive modeling (GAM). Connectivity components of retention and export were separately examined using GAM. The results indicate a positive trend in successful settlement; i.e., the magnitude of connectivity probabilities gradually increases over time. The increase in settlement success was primarily due to increased retention of natal propagules. Mechanistically this appears to be due to a general waning of current velocities over this temporal domain. Sensitivity of results to spawning seasonality and pelagic larval duration were also investigated.

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USING PHOTOGRAMMETRY TO QUANTIFY THE CONTRIBUTION OF SIX MORPHOLOGIES OF SCLERACTINIAN CORALS TO THE HABITAT COMPLEXITY IN A REEF: A RUGOSITY INDEX. (Abstract ID: 28756)

Coral reef biodiversity is at risk of declining. The relationship between biodiversity and habitat structural complexity (through surface rugosity - SR) is key to understand, measure, and monitor this decline. Reef-building scleractinian corals enhance biodiversity by increasing the number of three-dimensional structures, influencing key ecological processes such as predation and foraging. However, a comprehensive value of SR for different types of coral morphologies or size classes is still lacking. This study provides a value of SR for six common morphologies of scleractinian corals (branching, corymbose, foliose, massive, tabulate, and staghorn) across two different size classes. We used novel photogrammetric techniques, which enabled the precise reconstruction and measurement of 3D computer models of 108 coral specimens from photographs taken underwater. The staghorn morphology presented the highest value of SR. Branching, corymbose, and foliose morphologies had a significantly lower SR than staghorn corals, however SR did not differ significantly between these three morphs. The lowest values of SR were attributed to massive and tabulate morphs. Additionally, significant differences between size classes were found only for branching, foliose, and tabulate morphologies. Close-range photogrammetry provided a useful non-invasive technique to calculate SR at a high resolution. If incorporated in monitoring programs, this SR index will aid in quantifying the change in habitat complexity in a reef as a result of the shifts in community composition caused by disturbances.

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CARBONIC ANHYDRASE ACTIVITY IN THE SYMBIOTIC SEA ANEMONE*ANTHOPLEURA ELEGANTISSIMA* ACROSS A LATITUDINAL GRADIENT (Abstract ID: 29551)

The sea anemone Anthopleura elegantissima occurs in the intertidal zone from Mexico to Alaska. It is symbiotic with two genera of microalgae, the highly productive dinoflagellate Symbiodinium and the less productive chlorophyte Elliptochloris. The enzyme carbonic anhydrase (CA) catalyzes the interconversion of bicarbonate and CO2 and is known to play an important role in delivering CO2 to symbionts embedded deep in host tissues. Symbiont types in anemones are differentially distributed depending on latitude, tidal height, and light level. Anemones containing Symbiodinium are found at lower latitude, higher light environments compared to Elliptochloris-containing anemones that occur at higher latitude and lower light. Anemones in very low light lack symbionts. Previous research found aposymbiotic and Elliptochloris-containing anemones to have similar and low CA activity compared to Symbiodinium-containing anemones. We predicted that anemones collected from lower latitudes would have greater CA activity than anemones of the same symbiotic state at higher latitudes. To test the effect of light on CA, A. elegantissima from the Oregon coast were collected and split into three 30-day treatments: dark, low light, and high light. To test the effects of latitude A. elegantissima were collected from several locations ranging from central Oregon to the Puget Sound. Symbiont density counts and CA assays were performed in triplicate on each anemone. Our results suggest that latitude, symbiont type and density, and light interact to influence CA in A. elegantissima.

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BRIDGING THE DIVIDE BETWEEN SYSTEMATIC CONSERVATION PLANNING AND COMMUNITY-BASED CONSERVATION: A PHILIPPINES CASE STUDY (Abstract ID: 30119 | Poster ID: 645)

Systematic conservation planning is playing an increasingly important role in developing marine protected area (MPA) networks that accommodate conflicting needs between conservation and fisheries. Yet, conservation planning continues to fail to inform conservation action in the Coral Triangle, a region of high ecological importance. Failure to implement conservation plans in this region has primarily resulted from inadequate consideration of governance and socioeconomic factors. More specifically, there is a need to develop and evaluate methodologies to accommodate small-scale MPA governance systems and resource access needs of local stakeholders. This case study focuses on Sogod Bay in the Philippines to examine the conservation and fisheries trade-offs of explicitly incorporating marine tenure boundaries and spatial use patterns of small-scale fishers in conservation planning within the context of the Coral Triangle Initiative. The decision-support tool, Marxan with Zones, was applied to develop and evaluate three planning scenarios with increasing levels of complexity, where additional zones and fisheries information were added. Remote sensing data was used to identify priority areas for conservation, while participatory mapping exercises with fishers were conducted in over 100 communities to document the spatial resource patterns and minimize conservation costs. The results of this research illustrates the importance of developing conservation planning approaches within the broader governance and social context of the Coral Triangle.

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EFFECTS OF ALGAL OVERGROWTH ON WATER FLOW INTO AND OUT OF CORAL REEFS (Abstract ID: 28905)

Many coral reefs are being overgrown by algae. We studied how algae of different structure (branching vs. mat-forming) affected the flow of water into and out of the

spaces within Hawaiian reefs dominated by branching coral, *Porites compressa*. Such flow carries nutrients, oxygen, and prey to the organisms living in the reef, carries away wastes, and transports released larvae from and settling larvae into reefs. Transects across reefs since 2003 showed dominance in different years by living coral, mat-forming bubble algae, or branching algae on dead coral. Measurements of vertical water velocities into and out of reefs revealed that there was net flow into reefs in concave areas and net flow up out of reefs at convex areas when coral or branching algae dominated, but that flow was stopped when the cover of bubble algae was >60%. Field releases of larval mimics showed that fewer mimics contacted surfaces within reefs (where hydrodynamic forces on larvae are low enough that they can recruit) when there was algal cover, and that bubble algae stops more mimics than branching algae. Thus, algae not only compete with coral, but also can interfere with the recruitment of larvae and the transport of materials to and from the organisms living in the reef.
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MOLECULAR PHYLOGENETIC ANALYSIS OF THE SOFT CORAL FAMILY XENIIDAE (OCTOCORALLIA, ALCYONACEA) IN JAPAN AND TAIWAN (Abstract ID: 28322 | Poster ID: 75)

Species in the family Xeniidae are classified by only a small number of morphological characters. Therefore, species identification is quite difficult in this family and the species diversity is still unknown in Asia. Around Oshima Island in Miyazaki, Japan, and Lyudao Island in Taiwan, many soft corals including the Xeniidae inhabit. This study aims to know the species richness and diversity of the Xeniidae there, using molecular phylogenetic analysis. In this study, we collected xeniids including 248 specimens from Oshima isl. and Lyudao Isl. Based on the taxonomic references, we identified 22 species from seven genera (*Anthelia, Cespitularia, Efflatounaria, Heteroxenia, Sansibia, Sympodium, and Xenia*) in the Xeniidae. Fourteen out of 22 species were first records in Asia. In addition, we found total four undescribed species in both islands. We analyzed these samples phylogenetically using a mitochondrial marker (ND2) and a nuclear marker (ITS), together with additional samples of other families which were collected in Oshima isl. Our results revealed that all the seven genera except*Xenia* were monophyletic, indicating that traditional taxonomy based on the morphology reflects the molecular phylogenetic relationships among genera in the Xeniidae. On the other hand, *Xenia* was paraphyletic. More detailed morphological analysis of *Xenia* would be needed. In total, this study revealed high species diversity of the Xeniidae in Japan and Taiwan, which is comparable to that of the Great Barrier Reefs.

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THE BUTTERFLYFISHES (CHAETODONTIDAE) CONDITIONS IN RATATOTOK PENINSULA REEF, NORTH SULAWESI PROVINCE, INDONESIA (A MONITORING STUDY: 1996-2012) (Abstract ID: 28051 | Poster ID: 667)

Coral reef can be easily found along the coastline of the Ratatotok Peninsula which integrated in South-East Minahasa, North Sulawesi, Indonesia. For years this area was intensively used by villagers as fishing ground. In this area, a gold mining company PTNMR was operated in 1996 – 2004 and put it's tailing in the seabed of Buyat Bay. Since 1996 to 2012, an intensive monitoring establish by PT Newmont Minahasa Raya (PTNMR) to monitor closely the condition of butterfly fishes in the coastal areas of Ratatotok and Buyat bay, South-East Minahasa region, North Sulawesi, Indonesia. The objective of this study was to describe the butterfly fishes condition before, during, and after PTNMR operation. Butterfly fish can be use as an indicator of the health of coral reef. A Fish Visual Census method was applied for gathering butterfly fish data a long 50 m permanent transect established in four locations at the depth of 3 m and 10 m. All data were collected each year. There were several changes occurred during the monitoring period both on the number of genera and species of butterfly fishes on each study sites. The presences of butterfly fish were varied during the whole monitoring years. There are several factor were identified during this study that could be connected to the fluctuation of butterfly fish conditions. Unsustainable fishing practices (bomb fishing, cyaniding, anchoring, bottom gillnet), Crown of Thorn Starfish attacked, and coral disease weremajor factors that caused the changes in butterfly fish numbers. Keywords: butterfly fish, chaetodontidae, coral reef, ratatotok

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SURVEY OF BOAT BASED RECREATIONAL FISHERS IN THE U.S. VIRGIN ISLANDS (Abstract ID: 29518)

Recreational fishing is important to the residents and economy of the United States Virgin Islands (USVI). Government management efforts primarily focus on commercial fisheries in the USVI, largely due to assumptions regarding the relative importance of the recreational fishery and the paucity of data. While recreational fishers fish from the shore as well as boats, data indicate that boat based recreational fishing predominates. This study, conducted in 2014, characterized boat-based recreational fisheries, compared phone and mail survey methods, and determined if the annual vessel registration list maintained by the USVI, Division of Environmental Enforcement, could be used as a frame to survey recreational fishers. Of the 769 boat owners who were randomly selected from the 2013 boat registration list, 378 responded to the surveys. Of these, 38% recreationally fished. More boaters responded to phone surveys (60%) than mail surveys (40%). They fished primarily from their own power boats (81%) with a much smaller percentage fishing from sailboats (16%). Seventy-five percent fished for food and 42% considered themselves subsistence fishers. The primary families of fish targeted were the Scombridae (54%), Lutjanidae (49%), Coryphaenidae (37%), and Serranidae (32%). The most common recreational fishing technique was trolling. Fishers took an average of 3.3 trips per month with an average length of 4.4 hrs. The USVI vessel registration database is an important tool for surveying recreational fishermen, but it can only be used effectively if the information is updated annually.

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USING REGRESSION-BASED EFFECT SIZE META-ANALYSIS TO INVESTIGATE CORAL RESPONSES TO CLIMATE CHANGE (Abstract ID: 28422)

Attempts to quantify the effects of ocean acidification and warming (OAW) on scleractinian corals provide a growing body of response measurements. However, placing empirical results into an ecological context is difficult, owing to large variations that reflect both natural heterogeneity and scientific bias. This study addresses the heterogeneity of climate change induced changes in coral recruitment and calcification. To discern scientific bias and identify drivers of the remaining heterogeneity, 100 publications were analyzed using a combination of weighted mixed effects meta-regression and factorial effect size meta analysis. A linear model was applied to quantify the variation caused by differing stress levels across studies. The least squares predictions were then used to standardize individual study outcomes and weighted effect size meta-analysis was performed on original and standardized outcomes separately. Increased temperature significantly reduced larval survival, while ocean acidification hampered settlement and calcification. Differences were based on biological traits (genera and life cycle stage), environmental factors (climate and various characteristics of the collection site) and experimental design (presence of particulate food, filter size and experimental duration). Standardizing outcomes to linear model predictions proved useful in discerning strong sources of scientific bias. This approach can inform policy and management on changes in coral community structure associated with the expected future intensification of OAW.

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ECOLOGICAL DYNAMICS OF REEF CORALS ACROSS THE MIDDLE PLEISTOCENE CLIMATE TRANSITION (Abstract ID: 28287)

The Middle – Late Pleistocene (~1.2 – 0.125 Ma) climate is characterized by the intensification of cyclic oscillations between glacial (cool, low sea level) and interglacial (warm, high sea level) intervals. The fossil record, preserving a long-term dataset of coral reef communities composed of extant species, reveals that reef corals have persisted throughout the Pleistocene despite these frequent and dramatic climate fluctuations, some of which are similar in magnitude to projected modern climate change. Although it provides a valuable ecologic resource, the Middle to Late Pleistocene history of coral reef ecology remains largely unexplored, particularly in relation to climate changes during this critical period of reef expansion, and persistence, into modern reef ecosystems. Using deep drill core records through modern and historical reef environments, our work integrates taxonomic and trait-based paleontological data with paleoclimate and sedimentological interpretations as well as extant reef ecology to quantitatively evaluate the temporal distribution of coral taxa and functional traits in relation to past climate and environmental transitions. The overarching goal is to highlight the effects of past global climate and environmental change on reef community taxonomic and trait composition during the Middle to Late Pleistocene, when modern reef systems developed. These

findings enhance our understanding of the range in response of coral community structure and functional traits to rapid climate change and biogeographic variability.
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THE IMPORTANCE OF SOCIO-ECONOMIC INFORMATION FOR EFFECTIVE MANAGEMENT OF PROTECTED AREAS IN SIX STATES IN PALAU (Abstract ID: 28574)

Often, studies on the effectiveness and sustainability of protected areas focus heavily on biological and ecological information. While it is important to ascertain the progress of these protected areas according to such indicators, equally important is assessing progress towards socio-economic factors. Socio-economic information can provide resource managers essential information regarding perceived socio-economic trends and changes as they relate to these conservation areas. Globally, little information is known regarding the socio-economic impacts of conservation areas as well as the role of such areas in achieving human well-being outcomes. This study draws on a socio-economic study of communities living nearby to conservation areas in six States across Palau. Using a household questionnaire, a variety of socio-economic information was collected on: socio-demographics, livelihood activities and income, food and water security, and views of and support levels for the conservation areas. Overall, a number of indicators were also developed to assess the role of these conservation areas in improving livelihood outcomes in these States in Palau. Preliminary results of this study suggest that continuous socio-economic monitoring, educational outreach along with stricter law enforcement is necessary to ensure the success of these conservation areas in achieving human well-being management objectives. This study builds on a limited knowledge base of empirical socio-economic data the findings of which can be relevant to other small island developing states and elsewhere.

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EFFECTS OF SEDIMENTATION ON REEF-BUILDING SCLERACTINIAN CORALS IN SOUTHEAST FLORIDA (Abstract ID: 28920 | Poster ID: 436)

Southeast Florida coral reefs can be characterized as marginal coral reefs. Close proximity to overdeveloped land causes significant biological effects on nearshore coral reefs and coral-containing hardbottom communities. Sedimentation is arguably the most significant adverse impact on coral communities; and although natural events such as major storms can lead to sedimentation impacts, monitoring data from coastal projects in southeast Florida indicate that sedimentation is much higher when enhanced by anthropogenic activities. Large amounts of sediments are introduced to coastal water in southeast Florida annually from fixed inlets, dredging, and nourishment. Amounts of material and validity of data are discussed. Anthropogenically introduced sediments also bring a considerable amount of nutrients to nearshore reefs and hardbottom communities. Sediments of different granulometric content have varying effects on coral reef biota. Sedimentation of fine material has more extended and inhibitive effects on corals than coarser sand, and the effect on benthic communities expressed in smothering, mortality, and partial mortality is also higher. Mechanisms and consequences of such sedimentation are discussed. Measuring effects of turbidity and sedimentation is a challenging task in coral reefs and nearshore hardbottom habitats. The currently used nephelometric measurements of turbidity in Florida and sediment traps for sedimentation do not correlate with sediment deposition on reef biota. Methods of monitoring and evaluations of impact are discussed.

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ELECTROLYSIS, HALOGEN OXIDIZING AGENTS AND REEF RESTORATION (Abstract ID: 28902 | Poster ID: 469)

Applications for electrolysis of seawater include preventing fouling in piping systems and conditioning water for aquaculture. Electrolysis creates a variety of chlorine-produced oxidants that attack essential proteins of living tissues and react with organic materials, metals and other compounds (e.g., ammonia, nitrites, organic amines). The Biorock® process developed by Dr. T.J. Goreau and Dr. W. Hilbertz uses electrolysis for restoring reefs and enhancing growth and survival of corals. It is believed to act by elevating pH and alkalinity at the cathode and/or by reducing enzymatic costs for pumping cations and anions across cell membranes by providing an appropriate electrical gradient (Goreau, 2013). We hypothesize that a third mechanism for enhancing organisms may also be involved: inhibition of microorganisms by halogen oxidizing agents. Applying Faraday's laws of electrolysis for a system at 8.0 amperes and 90% efficiency gives an estimated ~230 grams of chlorine per day (equivalent to ~70 liters of gas at STP). In nature (i.e., an open system), diffuse follow-on reaction products (including hypochlorous acid, hypochlorite, hypobromous acid and hypobromite ion) may benefit macrobiota via inactivation of microbial pathogens and competitors, or by other improvements to water quality, as long as concentrations are too low to harm larger, ecotoxilogically less vulnerable organisms.

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PHYSICAL PROCESSES CONTROLLING CONNECTIVITY AMONG SOUTH FLORIDA CORAL REEFS AND PATHWAYS OF UPSTREAM RIVER INFLUENCE (Abstract ID: 29587)

A combination of in situ and satellite measurements and high resolution modeling are combined to study the connectivity among South Florida coral reef systems and the influence of upstream nutrient sources on local water properties. The study area covers the mesophotic Pulley Ridge reef on the Southwest Florida Shelf and the Florida Keys shallow reef system, extending to the Dry Tortugas. An unprecedented 3-year time series of currents and temperature reveals dominant circulation modes and pathways that are influenced by both shelf dynamics and the proximity of the large scale Loop Current (LC) - Florida Current (FC) system. Modulations of the LC/FC system, changes in LC core (from extended to retracted position in the Gulf of Mexico) and eddy passages were key factors in the connectivity pathways. Moreover, two major episodes of Mississippi water offshore removal took place during the study period, with in situ data quantifying their low-salinity signal around Pulley Ridge and the Florida Keys. Such episodes directly influence water quality around coral reefs in the Northern Gulf of Mexico, but also have remote impacts. For the first time, thick lenses of low salinity and high in nutrient content waters of Mississippi River origin were traced hundreds of kilometers away from the Mississippi Delta to the South Florida reefs, under both flooding and below normal Mississippi discharge conditions. A targeted numerical study elucidated the related processes and revealed complex pathways connecting remote reef systems in the Gulf of Mexico.

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A DECADE OF CORAL REEF BENTHIC COMMUNITY DYNAMICS FROM HIGH SPATIAL RESOLUTION SATELLITE IMAGERY AND FIELD SURVEY DATA (Abstract ID: 29054)

To develop, implement and evaluate management strategies coral reef scientists and managers require information to understand reefs and how they are changing. Maps showing the distribution of corals, algae, sand, rubble and rock are an essential component of this information. While annual point and plot based benthic community data have been collected over decades in long term ecological studies in marine environments, there has been limited work focussed on the creation and analysis of time series benthic community maps of coral reefs. This study presents a set of benthic community maps created from georeferenced field data in combination with high spatial resolution (< 2 m pixels) satellite imagery. Imagery and field data were collected annually over a 14 year period (2002-2015) for Heron Reef, Great Barrier Reef, Australia. A semi-automated object based classification was applied to pre-processed satellite imagery. Two thirds of the benthic field data was used as calibration data for the classification, while the remainder was used to validate the output maps. This method generated benthic community maps for each of the 14 years with overall accuracies ranging between 50-75%. Our output time series of coral reef benthic community maps provides the necessary information for assessment and understanding of the spatial and temporal dynamics of the reef environment at Heron reef. The methods developed provide the basis for building on existing field surveys at other locations to deliver long term benthic community maps for additional coastal and coral reef environments.

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A RE-EVALUATION OF NET COMMUNITY CALCIFICATION SENSITIVITY TO CARBONATE SATURATION STATE (Abstract ID: 28383)

Ocean acidification-induced declines in carbonate mineral saturation are concerning for coral reefs due to their presumed effects on coral reef community calcification. To improve forecasts of coral reef trajectories in an acidifying ocean, an increasing number of studies aim to elucidate the sensitivity of coral reef community calcification to carbonate saturation states. Many of these studies employ a simple linear regression approach. However, recent studies have highlighted the complications of interpreting these simple linear regressions, including the dependence of saturation state on calcification, the abil-

ity of many corals to up-regulate their internal calcification environments, and calcification rate dependence on photosynthesis leading to collinearity with other environmental variables. Here we re-evaluate a globally distributed set of published coral reef studies using statistical approaches capable of handling multiple environmental predictors (light, temperature, saturation state) to better quantify net community calcification sensitivity to carbonate mineral saturation state. This approach better constrains the range of community-scale calcification sensitivities to carbonate mineral saturation state and improves our ability to forecast OA effects on coral reef communities.

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A FUNCTIONAL MODEL OF BLACK BAND DISEASE BASED ON TRANSCRIPTOMICS (Abstract ID: 28353)

Black Band Disease is a persistent, pan geographic, coral disease. Despite its prevalence, the activities of the mat microbiota in the disease process remain unknown. We used metatranscriptomics to unravel the roles of the major mat constituents in the disease process in the coral Favia sp. from the Red Sea. We enriched and sequenced mRNA of the microbial consortium of the mat in BBD affected corals and compared with healthy tissues and healthy colonies. Identification of metabolically active bacteria of the disease front provides us with a glance at the microbial structure and function of the various constituents. Results showed a shift in bacterial composition and function in BBD affected colonies as compared with unaffected colonies. In the mat, members of Cyanobacteria, Bacteroidetes and Firmicutes bacterial phyla are numerous and are metabolically active. These groups are absent in healthy colonies of the same species. The Adenosylhomocysteinase enzyme produced by cyanobacteria and involved in cyanotoxin production, is the most transcribed gene in the band consortium. Members of the Bacilli class found in the mat transcribed high levels of Rhodanase, an enzyme responsible for cyanide detoxification. Vibrios are abundant in several pathogenic and non-pathogenic forms, and are highly active, most of them transcribing the thiamine ABC transporter. Desulfovibrio desulfuricans is the primary producer of sulfide in the band. These data offer a look at the varied functions of the microbiota in the disease mat enabling us to develop a functional model of this disease.

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3D PRINTED REEFS AS AN ENRICHMENT FOR NATURAL HABITATS (Abstract ID: 28855)

Increased insight into the complexity of reef functioning calls for new reef restoration strategies including updated geometrical designs and materials. In a pilot project in the Larvotto marine protected area (MPA) in Monaco, the new technology of 3D printing is currently being tested. Artificial reef (AR) units are being installed to enhance the rocky reef system of the MPA by creating habitat for sessile organisms and fish. Early 2016, a series of preparatory tests on material characteristics were carried out using 3D printed reef units and samples to prepare for an AR installation in the Larvotto MPA in summer 2016. As part of these tests and long-term pilot, samples of the printed material have been installed in the MPA in 2015 which are being monitored for material and ecological development. Once the AR units are installed, they will be monitored for their ecological performance during at least a 2 year monitoring period, along with regular monitoring of printed material samples. 3D printing technology is a valuable addition to existing reef restoration strategies allowing for construction of complex, tailored designs, use of native material such as sand and facilitating easy development, testing and adaptation of prototypes, materials and design processes. In combination with thorough studies on reef building processes and assessment of cost-effective proven production methods, 3D printed reefs are expected to allow for successful up scaling in projects. This article describes the 3D printing technique, design process and monitoring schedule of the pilot program.

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QUANTIFICATION OF CORAL BLEACHING AND CATASTROPHIC MORTALITY OF REEF-BUILDING CORALS ALONG WEST HAWAI'I ISLAND (Abstract ID: 29019)

In 2015, leeward reefs of Hawai'i Island suffered catastrophic coral mortality due to widespread and severe coral bleaching, resulting in more than 90% mortality for massive coral species, *Porites evermanni*, and 70% mortality for locally ubiquitous coral species, *Pocillopora meandrina*. The prevalence of coral bleaching and related health conditions (e.g. algal turf overgrowth) were quantified in October 2015 at 8 permanent monitoring transects and at 7 newly established shallow reef transects from South Kona to North Kohala. Benthic cover was compared from 2003 through 2016 for 24 permanent monitoring sites using standardized image analyses. Video transects during and after the bleaching event and citizen science reports from the local Eyes of the Reef Network provided supporting qualitative information. Survey results indicated unprecedented levels of coral bleaching for the majority of common coral species, resulting in a significant decline in total coral cover. Results from these surveys were used to inform state managers working to identify and apply effective management actions for reef recovery.

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WHERE ARE THE CRUSTACEA ON CORAL REEFS, AND DOES IT MATTER? (Abstract ID: 28503)

Crustaceans are one of the most widespread and speciose marine groups, performing key ecological roles in many ecosystems. They are one of the most influential taxa in aquatic trophic networks, providing a major connection between primary production and higher consumers. To investigate the role of crustaceans in the trophic network of a coral reef, abundance and biomass of crustaceans within different coral reef microhabitats was examined. Dead coral was by far the most important microhabitat type in terms of crustacean abundance (mean of 7838 individuals 100 cm−2) and biomass (0.75 g m−2, wet weight), producing values up to 3 orders of magnitude greater than the least important microhabitats (the epilithic algal matrix and fine-branching live coral). The importance of crustaceans and dead reef substrates to the trophic structure of coral reefs was further investigated using wrasses (Family: Labridae), one of the most abundant and diverse fish families on coral reefs. Gut content analyses found crustaceans in the guts of 93 % of the 30 wrasse genera investigated, with a distinct division between micro- and macro-crustacean predators: wrasses <80 mm standard length (SL) were predominantly micro-crustacean feeders, while wrasses >90 mm SL displayed a predominantly macro-crustacean diet. Micro-crustacean predators tended to specialise on specific crustacean taxa, whereas macro-crustacean predators consumed mostly brachyurans. These findings highlight the value of complex dead coral microhabitats and the importance of crustaceans in coral reef trophic networks.

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ENHANCING AND RESTORING CORAL REEFS FOR COASTAL DEFENCE: A SOFT SOLUTION CASE EXAMPLE FROM GRENADA (Abstract ID: 29853)

Coral reefs naturally protect coasts from erosion and flooding by attenuating wave energy and supplying sediment found on adjacent beaches. However, declines in their condition coupled with increasing rates of global sea level rise are jeopardizing communities and coastal infrastructure. The typical hard engineering solution to this problem is to construct breakwaters or groins is to protect high value shorelines even in places where shallow reef crests occur. Softer solutions such as coral restoration offer a cost effective alternative to traditional engineered solutions in some places. Degraded reefs can be structurally restored using both biological and physical techniques including the use of structural materials. However, few reef restoration projects have been designed with coastal protection as a primary objective and guidelines are lacking. Here we discuss the process of designing a low crested breakwater structure to restore the wave breaking properties of a degraded reef crest in Grenada. Structures were designed to withstand hurricane wave forces, have a minimum 30 year lifespan, and promote coralline algae and coral growth. A total of 30 meters of pilot structures were constructed in 2015 and installed on a high energy back reef environment using local materials, community labour, and a specially built shallow water barge. Monitoring results of the pilot structures suggest they perform similar to traditional submerged breakwaters but have significantly greater ecological benefits including the potential to enhance natural reef accretionary processes.
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SCALING UP CONSERVATION AND MANAGEMENT OF SMALL ISLAND NATIONS THROUGH SCIENCE-BASED LEARNING NETWORKS AND DATA PLATFORMS (Abstract ID: 30076)

The Eastern Caribbean (EC) islands are linked through coral reef ecosystems, oceanic currents, and a rich cultural heritage. To safeguard the region's biodiversity, restore fishery stocks and address climate change concerns, ECMMAN (Climate-Resilient Eastern Caribbean Marine Managed Areas Network) developed a Learning Network of partners from 6 EC countries to collect and share data on biodiversity, socioeconomics and marine management effectiveness. Results are available on CaribNode - an open access, decision-support web platform with geospatial tools to map the status of the islands resources (caribnode.org) and as easily understood Coral Reef Report Cards, pioneered by Healthy Reefs Initiative. Results from a new analysis included data from 277 reef surveys, benthic habitat maps and 44 MMAs. Reef condition examined by geographic zones and in/outside MMAs varied but several common findings included: Acropora palmata corals are recovering since 2005; More fleshy seaweed is found on leeward reefs and near settlements; Diadema populations are high; few large fish occur; and reefs with complex structure or protection had higher fish abundance. Small island nations rely heavily on their coastal resources yet chronic local impacts and climate change impacts threaten their limited resources. The 44 MMAs protect 5% of the shelf area, highlighting the need to strategically increase protection to meet the Caribbean Challenge's 20% goal by 2020. The resilience of these ecosystems will depend on effective local management and adopting transboundary, adaptive management strategies.

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THERMAL STRESS AGGRAVATES THE EFFECT OF OCEAN ACIDIFICATION ON FOUR CARIBBEAN REEF-BUILDING CORALS (Abstract ID: 28443)

Climate change leads to rising sea surface temperatures and changes in carbon chemistry that result in decreasing ocean pH and aragonite saturation state. Low pH has been shown to reduce calcification rates of symbiotic corals, but its impact under conditions of elevated light stress during thermal stress events is not known yet. Light absorbed in excess and increased photodamage is the main cause of the loss of photosynthetic activity during thermal stress, so the role of the light stress in this response should not be ignored. In this study we exposed four species of Caribbean reef-building corals Pseudodiploria strigosa, Orbicella faveolata, Montastraea cavernosa and O. annularis to heat stress conditions (pH8.1-32 °C); low pH (pH7.9-30 °C); and their combined effect (pH7.9-32 °C) for 10 days under natural light. Exposure to +2 °C in summer induced a loss of pigmentation, symbionts and photosynthetic activity and calcification due to increased accumulation of damage in Symbiodinium (decline in Fv/Fm). Low pH did not adversely affect coral photosynthesis and pigmentation, and only a slight decrease in the calcification rates was observed in P. strigosa. However, the combined effect of thermal stress and low pH significantly exacerbated the loss of calcification in P. strigosa and O. annularis, but not in the other two species. Considering the predicted changes for the ocean in the different global change scenarios, coral reefs are seriously threatened due to their adverse impact on the physiology of this symbiosis and carbon production, even prior to undergoing bleaching.

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GENE EXPRESSION UNDER THERMAL STRESS AND THE POTENTIAL FOR THERMAL ACCLIMATION IN A SYMBIOTIC CNIDARIAN (Abstract ID: 28069)

Despite its central importance for coral-reef ecosystems, the cnidarian-dinoflagellate symbiosis remains poorly understood at the genetic, molecular, and cellular levels. To explore the mechanisms underlying this symbiosis and their responses to stress, we used RNA-Seq to identify genes that are differentially expressed under thermal stress in the sea-anemone model system Aiptasia. The clonal line CC7 (containing its endogenous Clade A Symbiodinium symbiont), an aposymbiotic line derived from CC7, and the line CC7-SSB01 (aposymbiotic CC7 reinfected with a clonal Clade B Symbiodinium strain) were thermally stressed at 34°C and sampled at intervals for 10 d. We observed a strong upregulation in the mRNAs for heat-shock and other stress-response proteins at early time points (0-12 h) but distinct expression patterns when the symbiotic anemones began to bleach (≥48 h). The expression patterns were similar in all three lines, indicating that most, at least, are not related specifically to the presence of the endosymbionts. When we compared differentially expressed genes in Aiptasia to those identified by others in corals, up to 70% were found to be concordantly expressed in both hosts in response to thermal stress. We are also examining how prior thermal history influences the tolerance of symbiotic Aiptasia to subsequent thermal stress, finding that acclimation at elevated but sub-bleaching temperatures (30-32°C) decreases the rate and severity of bleaching during subsequent thermal stress at 34°C. Future studies will analyze gene expression in thermally acclimated animals.

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TOWARDS PROTECTING THE GREAT BARRIER REEF FROM LAND-BASED POLLUTION (Abstract ID: 28280)

The Great Barrier Reef (GBR) is an iconic coral reef system extending over 2,000 km along the north-east coast of Australia. Global recognition of its Outstanding Universal Value resulted in the listing of the 348,000 km2 GBR World Heritage Area (WHA) by UNESCO in 1981. Despite various levels of national and international protection, the condition of GBR ecosystems has deteriorated over the past decades, with land-based pollution from the adjacent watershed being a major cause for this decline. Moreover, poor water quality from land-based runoff remains a major threat to the future condition of the GBR WHA. To address land-based pollution, the Australian and Queensland Governments have implemented a range of policy initiatives since 2003. Here, we discuss the evidence on (i) the decline in GBR water quality and ecosystem condition, and (ii) the effectiveness of the existing initiatives to reduce discharge of land-based pollutants into GBR waters. We conclude that recent efforts in the GBR watershed to reduce land-based pollution are not sufficient to protect the GBR ecosystems from declining water quality within the aspired timeframes. To increase the likelihood of protecting GBR ecosystems from land-based pollution into the future, we identify incremental improvements that can be made to current approaches, and highlight potential transformational changes to current agricultural land uses, that may also provide guidance for the management of other marine ecosystems around the world.

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GLOBAL TARGETS FOR MARINE RESERVE COVERAGE ON UNREGULATED CORAL REEFS (Abstract ID: 27886)

Marine reserves are the primary tool for biodiversity conservation, but increasingly relied upon also to manage fisheries, particularly in complex and over-exploited tropical systems. While global agreements define a minimum percentage of habitats to be protected for more effective conservation, associated impacts on fisheries are unclear and could weaken food security if over-exploitation increases outside reserves. Here, we present a systematic analysis of the ability of reserves to rebuild complex and unregulated fisheries, and we identify maximum reserve coverages for biodiversity conservation that are unlikely to impair long-term fishery performance. We find that large reserves, exporting less than 30% of larvae, might impair fishery performance, but that realistic reserve network designs should benefit most complex fisheries. Specifically on coral reefs, where larval dispersal distances of many target species are likely to exceed their home ranges as adults, negative fishery impacts are unlikely. Even the modest UN Aichi target of 10% reserve coverage can then help rebuild depleted catch. However, 20-30% reserve coverage will likely deliver better biodiversity outcomes while not harming healthy fisheries and allowing for more efficient rebuilding of substantially depleted fish populations and catch.

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IS THE RED SEA CORAL *STYLOPHORA PISTILLATA* ALREADY PREPARED FOR FUTURE OCEAN CONDITIONS? (Abstract ID: 28629)

Migration of corals through a hot water bottleneck in the Southern Red Sea, following the last glacial period, has led to a situation where corals in the Northern Red Sea now

express high thermal thresholds while living at suboptimal lower temperatures. We tested to what extent the coral*Stylophora pistillata* is capable of resisting future ocean conditions as a result of this selection. We combined chlorophyll fluorescence analysis, biochemical markers, and respirometry with state of the art correlative TEM and NanoSIMS techniques to obtain a holistic picture on the physiological impact of the isolated and combined effects of temperature (+5°C) and pH (-0.3 units relative to ambient). After 2 months, most physiological variables were either unaffected or improved by the combined effect of high temperature and low pH. Net oxygen production effectively doubled due to changes in photochemistry and higher symbiont pigmentation, and we observed higher values for holobiont productivity with P:R ratios of up to 1.72. No significant change in the activity of enzymatic antioxidants or daily calcification was detected. NanoSIMS data revealed that carbon and nitrogen assimilation in the symbiont and host gastrodermis are negatively affected by isolated temperature stress. However, no difference in the proportion of symbiont-derived carbon in the host lipids was observed and neither protein nor overall carbohydrate content was affected in either partner. Our data point to a high degree of physiological resistance of this coral to the expected global trends in ocean conditions and emphasize the urgency of reducing local stressors in this region.

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TRANSGENERATIONAL EFFECTS OF TEMPERATURE STRESS: IMPACTS ON AND BEYOND CORAL REPRODUCTION (Abstract ID: 28172)

As oceans warm, corals are exposed to temperatures outside their normal range, causing stress to the organism. Previous studies demonstrate that temperature stress negatively impacts the reproductive output of corals. However, the transgenerational impacts of temperature stress on corals are unknown. Additionally, corals are expected to experience warmer temperatures months before the spawning season, when their gametes are still developing. To assess transgenerational effects of temperature stress during gametogenesis, colonies of *Montastraea cavernosa* were exposed to elevated temperature for two weeks four months prior to spawning, and then returned to the reef. At spawning, gametes from temperature stressed and unstressed corals were combined to create four fertilization crosses: unstressed eggs and sperm, unstressed eggs with stressed sperm, stressed eggs with unstressed sperm, and stressed eggs and sperm. Larvae and juveniles from each cross were kept at ambient (29°C) and elevated (31°C) temperatures. Larvae and juveniles originating from stressed gametes had lower survival. When temperature stress occurred during both gametogenesis and larval or juvenile development, the decrease in larval and juvenile survival was exacerbated. These results demonstrate that temperature stress during gametogenesis has latent effects on larval and juvenile survival.

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HOW TIME AND SPACE INFLUENCE LIFE-HISTORY TRAITS IN CORAL COMMUNITIES (Abstract ID: 29230)

Scleractinian corals have persisted under environmental shifts that have occurred over tens of thousands of years, and meanwhile evolved a vast array of life history traits. Today's rates of change, however, are much higher and organisms have to be able to adapt a lot faster. In the first example we use a spatially explicit, individual-based model to explore three important life history traits of corals (i.e. heat resistance, competitiveness and growth performance) under various environmental settings. Additionally, we estimate the required adaptation potential for a coral community in order to survive this century under different IPCC climate scenarios. Our findings show that (i) direct competition among corals seems to become a subordinate trait, and (ii) under the RCP4.5 scenario (2 °C temperature increase) a a simulated coral community would only maintain 5-15 % cover if it could adapt to Climate Change within 20-30 years, which is highly unlikely. The resulting community would then mainly consist of temperature-tolerant and some fast-growing species. In the current project we monitor environmental conditions of distinct habitat types at 7 stations along Heron Island Reef continuously for two years, and respiration rates of typical benthic communities at two stations seasonally. Based on these data we will use a variation of the individual-based modelling approach above to analyze the importance of particular life history traits in benthic communities at distinct locations, measure their productivity rates and estimate their trajectories under Climate Change scenarios.
http://www.coralreefecosystems.org/dr-andreas-kubicek/

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INCIDENCE AND CAUSE OF PINK/PURPLE PIGMENTATION SYNDROME IN GENUS *PORITES* IN OKINAWA ISLAND. (Abstract ID: 28549 | Poster ID: 158)

Specific pink color abnormality in genus *Porites* has been reported from many regions in recent years. Pink color abnormality has various types; such as pink lines, pink spots, pink patches, pink bands. Together, these are called pink pigmentation syndrome (PPS), and a pink fluorescent color is seen in all types. However, there has been little research from Okinawa on PPS. Moreover, not only PPS but also purple pigmentation is seen in Okinawan Porites (combined PPuPS). In this study, we investigated the frequency of PPuPS in Okinawa, and focused on defining a cause(s) for this syndrome. We examined 17 sites around Okinawa Island by taking images of more than 30 Porites colonies per site. PPuPS level, presence of epibionts, and presence of macroalgae were checked from photographs. Also, we calculated PPuPS incidence and examined relationships of PPuPS to epibionts and algae by multi-dimensional scaling (MDS) and principal component analysis (PCA). Most sites showed approximately 80% incidence of PPS and approximately 50% incidence of purple pigmentation syndrome (PuPS). However, sites at southern Okinawa (Odo, Oujima) uniquely showed a very lowly incidence of PPuPS (PPS: 37.5-48.6%, PuPS: 9.4-13.5%). Both sites also showed a relatively low quantity of epibionts and macroalgae, but we could not statistically determine the possible causes of color abnormality to epibionts or macroalgae. It may be possible clarify a cause of PPuPS by investigating these two sites in more detail.

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BALANCING AREA AND EFFECTIVENESS: MPA EXPANSION VS. MANAGEMENT ENFORCEMENT IN MEETING GLOBAL CONSERVATION TARGETS (Abstract ID: 27800)

Protected area coverage has expanded rapidly in recent decades, yet there has been considerable debate surrounding the ability of protected areas to conserve biodiversity through establishment alone. While protected areas set geographical boundaries, enforcement of the laws and regulations within them is a fundamental driver of user compliance and reserve success, which highlights the importance of active management. However, non-compliance is widespread and threatens the objectives and benefits which protected areas are intended to provide. This is particularly true in marine environments, which have experienced an estimated 513% expansion since 1990 but have documented continued shortfalls in management and illegal resource extraction. With international targets (i.e. Aichi Target 11) calling for large increases in marine protected area (MPA) coverage, a critical question arises: to achieve maximum conservation benefits are limited funds best spent on expanding the current MPA network or managing existing MPAs to a higher degree? Here, we explore this question in no-take MPAs by modelling fisheries and conservation benefits in a non-spatially distributed, unconstrained system. We then apply this model to the Great Barrier Reef Marine Park to retrospectively analyse the 2004 re-zoning expansion and its effectiveness in protecting the commercially and ecologically valuable species, the coral trout (Plectropomus leopardus).

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REEF CONSTRUCTION AND DECONSTRUCTION IN THE FLORIDA KEYS, U.S.A. (Abstract ID: 28170)

Mirroring global trends, coral reefs in the Florida Keys have lost significant coral cover since the 1970s. The main reef-building process, coral calcification, has undoubtedly slowed on a region-wide scale resulting from declines in cover of massive head corals and the large, branching *Acropora* spp. In examining the coral record, however, it remains to be determined whether coral growth rates (linear extension or calcification) have systematically changed over the past two centuries. We present spatial and temporal patterns in existing and new data on coral growth rates for four reef-building species in the Florida Keys. We also examine the deconstruction side of the equation by quantifying decadal-scale rates of reef erosion by completing a study started in 1998 wherein dead coral heads were fitted with erosion-resistant cement and stainless-steel markers. In 2015, we revisited the site and found an average of 94 mm (std dev: 56) of reef elevation loss at 28 stations during the 17.3 year period. With the estimated rate of reef erosion at 5.4 mm per year, reefs that are presently devoid of coral cover in the Florida Keys are rapidly being eaten away by grazers and bioeroders. Conservation efforts intended to increase the abundance of parrotfish may, therefore, have adverse results in the Florida Keys and in other areas where herbivores are not targeted fisheries. Managing reefs with respect to physical resilience, in addition to ecological resilience, could optimize the expenditure of resources in conserving reefs and the services they provide.

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QUANTIFYING THE ACCUMULATION OF MARINE DEBRIS NEAR CORAL REEFS USING AERIAL IMAGERY AND GIS ANALYSIS (Abstract ID: 28822 | Poster ID: 411)

Hawaii's coral reef ecosystem is a valuable natural resource that supports a unique and diverse host of marine life, providing sustenance to Hawaii and its inhabitants. The Great Tsunami of 2011 had devastating effects on Japan, dispersing millions of tons of debris, some of which drifted great distances across the Pacific Ocean via wind and current. This Japanese tsunami marine debris (JTMD), which includes an assortment of plastics, buoys, vessels and large docks, continues to make its way into Hawaiian waters. Debris poses serious risk to Hawaii's fragile reefs, including entanglement of reef dwelling organisms, introduction of aquatic invasive species, and physical breakage, particularly from large debris like vessels. In order to characterize the ecological consequences of JTMD, it is important to understand and quantify where and what debris is accumulating. Given the remoteness of coastlines in the Hawaiian Islands, large scale surveillance efforts are needed to identify these "hotspots" of marine debris. This project collected high-resolution aerial imagery and then, using ArcGIS software, identified and characterized marine debris densities along Hawaiian shores. This innovative technique allows analysts to identify hotspots across the state and their association with coral reefs. The project method could also prove useful in other sites or to quantify different targets, such as sedimentation or coastal wildlife. The study's findings will inform resource management on the part of federal and state government and local nonprofit and community groups.

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THE GENUS WAMINOA ASSOCIATED WITH PALYTHOA HELIODISCUS (Abstract ID: 29253 | Poster ID: 62)

*Waminoa* species live on soft and stony corals, and can increase in number until they cover the entire host, disturbing the host's photosynthesis. Furthermore, *Waminoa* species feed on coral mucus and steal food from host corals. Therefore the study *Waminoa* species can be considered important in understanding coral reef ecosystems. There are two genera of symbiotic dinoflagellates within *Waminoa* species, *Symbiodinium* and *Amphidinium*. Previous studies have considered that *Symbiodinium* is acquired from host corals but phylogenetic analyses have revealed that the *Symbiodinium* of*Waminoa* spp. are different from the *Symbiodinium* of the host corals. Instead, the *Symbiodinium* and *Amphidinium* of *Waminoa* species are acquired via vertical transmission. In this study in Okinawa, Japan, we found a *Waminoa* species on the zoantharian *Palythoa heliodiscus* with a white line on the dorsal side, different from described species. Additionally, to understand if the *Symbiodinium* within *Waminoa* sp. are from the host *P. heliodiscus* or not, the internal transcribed spacer region of ribosomal DNA (ITS-rDNA) sequences of *Symbiodinium* from *Waminoa* sp. and *P. heliodiscus*were compared. These results represent the first described report of*Waminoa* sp. on *Palythoa*.

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ADAPTIVE STRATEGIES OF SCLERACTINIAN CORALS (Abstract ID: 29093)

One of the major goals of ecology is to identify the way organisms meet the challenge of existence in different environments. One approach, termed the Universal Adaptive Strategy Theory (UAST), has been hypothesised to apply to all creatures on the tree of life, including corals. The UAST reflects the means by which an organism allocates resources between acquisition, maintenance or regeneration. However, previous attempts to classify scleractinian corals according to UAST have been inconclusive, perhaps because the traits used in these analyses were not chosen following the principles set out in the theory. Here, we test the ubiquity of UAST theory using a recently compiled online database of coral traits. The application of UAST will lead to improved insight into the variation of responses in coral assemblages. Subsequently, this will facilitate better informed management decision-making by allowing predicting the response of dynamic reef systems to different environmental conditions.

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USING POLICY AND CORAL RESTORATION ACTION TO MITIGATE AND PREVENT INVASIONS BY AQUATIC ALIENS ON HAWAI'I'S CORAL REEFS (Abstract ID: 28949 | Poster ID: 621)

The introduction of aquatic invasive species (AIS) threatens Hawai'i's coral species diversity and existence, especially through vectors of transfer such as biofouling of ballast water and ship hulls. A single AIS can have the ability to monopolize food, space resources, and cause the endangerment or extinction of endemic coral. The Hawaiian Islands are the most isolated archipelago in the world as they are 2500 miles away from the nearest continent and 1000 miles from the nearest islands. This allows for spectacular speciation that occurs nowhere else. For example, more than 20% of coral species are endemic to Hawai'i. Not only do corals provide food and refuge for other organisms inhabiting coral reefs, they also provide important recreational, scenic, and in turn, economic opportunities. Presently, around 350 AIS have been found in the Hawaiian Islands, and the majority have been unintentionally brought over through the maritime industry. For example, 80% of consumable goods in Hawai'i are imported by ships. As a result, the frequency at which a single species of AIS may visit the state is relatively high thus constantly posing the threat of invasion. Though Hawai'i coral reefs are at a severe disadvantage because of AIS introductions, hope is not lost. This presentation will focus on the current state of affairs with regards to coral-reef-associated AIS preventative and reactive measures including coral restoration projects and biofouling regulation development/implementation for the State of Hawai'i.

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SOCIO-ECOLOGICAL IMPLICATION OF HUMAN MULTI-IMPACTS ON CORAL REEF ECOSYSTEM AND ~ PALAU AS A CASE STUDY~ (Abstract ID: 28985)

Coral reef ecosystem supplies a number of ecosystem services that sustain human society. However, the ongoing rapid and multiple environmental changes caused by human activities are suspected to disturb the dynamic equilibrium and result in the loss of present reef ecosystem. The loss of reef ecosystems will have a critical impact in island society where socio-ecological interactions are highly linked. This study focus on the reef ecosystem in Palau. We first conducted surveys around coral reefs on different environment parameters including nutrient, chla, POC/N, carbonate chemistry and evaluated the correlation with the coral community structure. We found that aragonite saturation, nutrient condition and turbidity are the 3 main factors that define coral community structure. Then, we focus on the two stress, waste water discharge and ocean acidification (OA), and evaluate the potential ongoing impacts on Palau reef ecosystem. Results demonstrated that both OA and excess nutrient discharge is already causing degradation to the coral community, which may lead to the decrease of benefit such as coastal protection and tourism. These results suggest local management such as sewage treatment, together with the consideration of climate change, will be essential for management of Palau coral reef ecosystem.
http://harukoku.sakura.ne.jp/Kurihara/Welcome.html

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PHYLOGENY AND DIVERSITY OF SEA PENS IN SOUTHERN JAPAN (Abstract ID: 29358 | Poster ID: 64)

Sea pens are important components of sandy and muddy marine ecosystems from shallow to deep waters around the world. However, our understanding of the phylogenetic relationships of sea pens is very poor and classification is confused and difficult. Despite

high biodiversity in the Ryukyu Islands (southern Japan), records of sea pens are very few. In this study, we collected sea pen specimens from the Ryukyu Islands and Sagami Bay and analyzed the phylogenies of two mitochondorial protein coding genes, MutS and the ND2 region. Consequently, family Virgulariidae was not a monophyetic group, nor was Pennatulidae or Kophobelemnidae. As well,*Pteroeides* with acrozooids formed a monophyly sister to a clade of*Pteroeides* without acrozooids and these two groups were separated by high genetic distance. As *Sclerobelemnon* (Kophobelemnidae) formed a paraphyletic group including *Cavernulina* (Veretillidae), this suggests that*Cavernulina* is derived from *Sclerobelemnon*. The traditional classification scheme is not reflected in phylogenetic relationships and therefore requires revisions. Additionally, from this research, we report the first records of*Scytalium* (Virgulariidae) and *Echinoptilum* (Echinoptilidae) in the Ryukyu Islands. Overall, we have confirmed at least 12 species-groups in Okinawa . It is clear more research is needed on this understudied group in Okinawa.

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MANIPULATING CORAL-ALGAL SYMBIOSES TO ASSESS THE RELATIVE CONTRIBUTION OF SYMBIONT IDENTITY VS. HOST ACCLIMATIZATION IN DETERMINING HOLOBIONT THERMOTOLERANCE. (Abstract ID: 29607)

Reef corals that have recovered from thermal bleaching often show increased tolerance to thermal stress, but it is not clear how much of this increased thermotolerance is due to changes in algal symbiont communities vs. acclimatization of the coral host. This question can be addressed by manipulating corals to host different symbiont assemblages. Replicate cores from 4 colonies of the Caribbean coral Siderastrea siderea were heat-bleached (by exposure to 32 C for 10 days), or herbicide-bleached (by exposure to DCMU for 10 days) and allowed to recover under high or low light at 26 C (resulting in recovery with symbiont assemblages that varied in their abundance of Symbiodinium D1a). This gave replicate corals of the same genotype that either had or had not undergone thermal acclimatization (as measured by tag-based RNA seq) and either had or had not changed their algal symbiont communities (as measured by an actin-based qPCR assay). Corals were common-gardened under ambient light conditions for 1 month before being exposed to a second period of thermal stress (32 C for 10 days). Thermotolerance was measured as a combination of photochemical efficiency (using chlorophyll fluorometry) and symbiont loss (using qPCR). This approach allows us to tease apart the contribution of host acclimatization and shifts in symbiont assemblage to holobiont thermotolerance. As reefs continue to warm over the coming decades, understanding the relative importance of different mechanisms in changing coral thermotolerance is critical to managing reefs to maximize coral survival trajectories.

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HYPERSPECTRAL IMAGING OF CORALS IN LABORATORY CONDITIONS (Abstract ID: 28678 | Poster ID: 546)

Spectral signatures of corals, seagrasses, macroalgae and other coral reef habitats are needed for remote sensing as well as for physiological and ecological studies. The necessary reflectance spectra have been collected both in situ and in laboratory conditions. Fiber optics probes were used to collect the data. However, coloration of corals may vary significantly within a coral colony. Such variability is common also in the case of macroalgae. Collecting spectral data from all these differently colored parts with a fiber optics is a tedious task and the total studied area still covers just a small fraction of the colony. We designed a scanning bench for hyperspectral imaging spectrometer HySpex that allows to collect high resolution imagery in laboratory and outdoors (not in marine environment). Spectral range of HySpex is 410.6-989.2 nm, spectral resolution 2.5 nm and the imagery is collected with high spatial resolution. For example, with the 30 cm lens the spatial resolution is around 0.1 mm. Also a 100 cm lens is available and the altitude of the spectrometer above the study object is adjustable. We tested performance of the system by collecting imagery of live (fluorescent and non-fluorescent species) and dead corals in an shallow water aquarium which was placed under the imaging spectrometer. The imagery revealed remarkable variability in coral reflectance at subcentimeter scale. This instrument can be used in multitude of coral reef studies, but the potential range of applications is wide.

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SHELL AND PEARL CHROMATIC VARIATION IN PINCTADA MARGARITIFERA AMONG CORAL REEF ENVIRONMENTS IN FRENCH POLYNESIA (Abstract ID: 27862)

The black-lipped pearl oyster Pinctada margaritifera inhabits subtropical and tropical coral reefs, and is particularly abundant in the lagoons of French Polynesia. Its aquaculture is developed in lagoons of 25 atolls and islands widely geographically spread over 14° longitude and therefore subject to disparate environmental regimes. This species exhibits a remarkable wide range of colors of the shell and cultured pearls. The factors that contribute to the color determination include the oyster phenotype (genetic), the culture zone (environment) and their interactions. To understand the origin of the phenotypic color variations, several approaches have been approached, both at a genetic and a macro-environmental level. Specific crosses are set up to show the clear pattern of phenotypic inheritance of flesh and shell color mutation consistent with Mendelian inheritance and expression of a single-locus, dominant trait. Relations to environmental variation were studied using first generation P. margaritifera families, produced through hatchery system, to test in field for their potential. For pearl color, classification tree model could be built to predict, according to shell phenotype and culture location, the color and darkness level of harvested pearls. Lustre was shown to be more influenced by the environment than by phenotype. All these preliminary results have implications for a better understanding of P. margaritifera adaptation to the environment, associated with its phenotypic plasticity.

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GROUNDWATER-ASSOCIATED NUTRIENTS IMPACT BENTHIC PRODCUTIVITY AND NUTRIENT UPTAKE ACROSS A REEF FLAT IN MAUNALUA BAY, HAWAI'I (Abstract ID: 28765)

Submarine groundwater discharge (SGD) can contain high nutrient concentrations from sources that include agricultural activities, urbanization, and leaky septic systems. Coral reef systems are especially sensitive to increases in nutrient concentrations which can change community composition, productivity, and nutrient uptake by the benthos. In this study we used salinity as a proxy to map groundwater-derived nutrients, across a coastal reef in Maunalua Bay, Oahu over time. Nutrient relationships were derived by sampling synoptically along an onshore to offshore transect from the SGD seeps. Using in situ benthic chambers, we mapped the C-uptake and dissolved inorganic nitrogen (DIN) uptake by different species across the reef. We also mapped algal species distributions, and quantified the contribution of different species to benthic productivity and DIN uptake across the reef. Results indicate that DIN uptake and productivity vary among species and vary spatially across the reef. This spatial pattern of nutrient uptake and productivity in turn affects the concentration of important chemical constituents of the water transiting the reef system, which has implications for reef resilience and health.

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COMPETITION AND ITS CONSEQUENCES ON CHANGING CARIBBEAN CORAL REEFS (Abstract ID: 29817)

Coral cover on Caribbean coral reefs has dramatically declined over the last several decades accompanied by an increase in "weedy" coral species, gorgonians and sponges. Loss of coral cover and diversity can lead to decreased structural complexity, fish populations and decreased coral recruitment, ultimately reducing productivity, ecosystem function and the recreational value of reefs. Thus, understanding the outcomes of competitive interactions between corals and other benthic species in the context of changing community structure on Caribbean coral reefs is critical. We combined observational field surveys and a common garden experiment to understand the frequency, outcome, and consequences of competition between corals, sponges, encrusting gorgonians and zoanthids. We found consistent competitive outcomes between species. Interestingly, we observed that multiple species grew most when paired with a conspecific competitor. Importantly, we found that several increasingly common benthic species are able to rapidly outcompete key reef building corals. Our data provide insights regarding the mechanisms driving observed shifts in benthic community structure on Caribbean reefs. Further, these results provide some of the first contemporary empirical data that can be used to develop competitive models to predict shifts in coral reef community composition and reef function.

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DIRECT FINANCING OF CONSERVAITON ON THE GROUND: A MODEL FOR PALAU AND BEYOND (Abstract ID: 29694)

Local managers and conservation leaders – the cornerstone of marine management success – must have dependable and adequate resources, and freedom from political interference. We report out on a public/private partnership model that directly finances ground-level efforts by these key actors. The model incorporates simple incentives and the checks and balances necessary to effectively implement programs. It also aligns

user fee sources with private funds, risk capital sources, and technologies that reduce costs and increase management efficacy. Palau has a network of marine protected areas (MPAs) and conservation programs that rely on bottom-up implementation. Our model caters to local managers, who must juggle a suite of challenges related to enforcement of no-take zones and ever-changing local politics. These conservation leaders also require financing to develop local capacity, engage community outreach, and use technology effectively. We seek to reduce their time spent navigating political landscapes and securing adequate funding and related resources, allowing more time for key management operations. Moreover, our approach rewards effective management and leadership. Model implementation is proceeding under a formal Memorandum of Understanding (MoU) with the Republic of Palau. The effort is aligned with overarching regional initiatives, including the Micronesia Challenge, Protected Area Networks, and Palau's emerging National Marine Sanctuary.
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IMPACTS OF NEAR SHORE STRESSORS ON FERTILIZATION SUCCESS IN THE STONY CORAL, *MONTIPORA CAPITATA* (Abstract ID: 28818 | Poster ID: 171)

In Hawaii, runoff and thermal stress are some of the main physical stressors on coral reef communities. Successful reproduction and recruitment is important in promoting reef resilience and recovery. While the impacts of sediment, salinity, and temperature on adult corals have been extensively studied, their effects on fertilization of Hawaiian corals remain poorly understood. In this study, we tested the hypotheses that fertilization would be negatively affected by high sediment concentrations, low salinity, and high temperature. In June and July 2015, we collected bundles of sperm and eggs from the dominant Hawaiian coral, *Montipora capitata*, and determined fertilization success in various treatments and found that fertilization success differed among treatments. Fertilization success significantly decreased in both the low salinity and high temperature treatments, however, it did not differ with high sediment loads. These results suggest that fertilization of *Montipora capitata* can be successful under high sediment concentrations, but is negatively affected under anomalously high temperature or low salinity. Kaneohe Bay has a long environmental history of high sediment loads and further studies are needed to ascertain if these corals are locally adapted to suspended sediment and are better able to successfully reproduce under such harsh conditions.

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AGENT BASED MODELLING AS A TOOL TO MANAGE DREDGING IMAPCT ON CORAL SPAWNING (Abstract ID: 28614)

Turbidity and sedimentation generated by dredging and dredge material disposal can seriously affect coral reproduction during spawning periods. Numerical modelling can be used as a powerful tool to predict and manage the risk of impacts. Dredge plume modelling predicts the plume dispersion and associated turbidity and sedimentation rates, and simultaneous agent based modelling is used to predict the pathways of released gametes and connectivity between reefs on a regional scale. Combined with set tolerance limits, the modelling can be used to predict the level of impacts from a given programme, and scenario type modelling can be used to optimise the dredging plan to minimise impacts. Taking this a step further, a reliable forecast model provides the opportunity to make informed proactive and adaptive management decisions of the dredging during a spawning period to minimise the impact on the coral gametes. The presentation will show examples of dredge plume and coral spawn modelling in Western Australia and discuss how this can be used to proactively manage the risks of impacts. The study was carried out using DHI MIKE Agent Based Modelling (ABM) tool. This integrates hydrodynamic, wave, sediment transport and the ABM models to define the dredge plume dispersion and concurrent behaviour of coral larvae in response to the environment. Examples of management measures will be provided and discussed.

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A SYSTEMATIC REVISION OF *SYMBIODINIUM*: "CLADES" ARE GENERA (Abstract ID: 29647)

Twenty-five years have passed since the first phylogenetic data revealed that members of the dinoflagellate 'genus' Symbiodinium comprised highly divergent lineages. Hundreds of published papers on cnidarian-dinoflagellate symbioses confirm genetic variation within this microalgal group is both evolutionarily broad and highly diverse. Traditionally, these divergent lineages have been referred to in the literature as "Clades." Although many researchers recognize the extent of diversity within each Clade, all too often these designations are still used and discussed in ways that suggest they are equivalent to species. However, various lines of evidence indicate that most Clades contain numerous ecologically and physiologically distinct entities ('types' or 'sub-clades'), many of which represent reproductively isolated species. Recent efforts have begun to populate each Clade with formally described taxa, but there remain hundreds of entities that merit unique binomials. As the community moves forward revising Symbiodinium systematics, the imperative question is whether the informal Clade structure effectively organizes this species diversity in a hierarchical framework. Do Clade designations promote or rather hinder scientific discourse and the advancement of knowledge? As emerging evidence from comparative genomics further clarifies the phylogenetic relationships among Symbiodinium, we argue that Clades have outlived their usefulness and should be replaced with generic designations that more accurately reflect their taxonomic rank.

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RELATIONSHIPS BETWEEN THE ABUNDANCE OF BUTTERFLYFISHES AND CORAL COMMUNITIES IN THE REEF AREAS OF TUTICORIN REGION, GULF OF MANNAR, INDIA (Abstract ID: 28744)

Reef fishes play a vital role in any reef ecosystem and butterflyfishes are in close association with corals. Despite their ecological importance, butterflyfishes are poorly studied and documented in Gulf of Mannar, India. Here we report the relationship between the coral growth forms and abundance of butterflyfishes in four islands of Tuticorin region of Gulf of Mannar namely Vaan, Koswari, Kariyachalli and Vilanguchalli islands. Live coral cover, coral diversity, coral growth form, butterfish abundance and diversity were assessed during 2014. Live coral cover was found to be between 17.7±1.45 and 37.24±2.54%. Visual census using belt transects was done to assess the fish communities and 5 butterflyfish species belonging to the genus Chaetodon were noticed. Among the 5 species, Chaetodon collare and C.octofasciatus were found to be dominant. Highest abundance of butterflyfishes was recorded in Kariyachalli Island with 117 50/m2 where the percentage of live coral was also highest (37.24%). The abundance of C.octofasciatus and C.collare showed significant correlation with live coral cover. The total Chaetodontidae density strongly correlated with the scleractinian coral cover and with the cover of branching corals .The results suggest the existence of strong links between chaetodontids and the cover of scleractinian corals. Further studies are needed to assess the behavioural and spatial distribution of these fishes in Gulf of mannar to get the baseline information for the better management.

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CORAL SETTLEMENT, SURVIVABILITY, AND DIVERSITY IN A HEAVILY STRESSED SUB-OPTIMAL URBAN REEF ENVIRONMENT IN THE FIJI ISLANDS (Abstract ID: 27793)

A relic inshore reef ecosystem located 400 meters from the Fijian capital City of Suva and adjacent industrial area was monitored monthly from July 2014 to July 2015 for coral cover, recruitment rates, sedimentation rates, light intensity, temperature, salinity, and dissolved oxygen magnitudes. Five permanent quadrats, five settlement tile racks, five sediment traps, and two light and temperature loggers were deployed in this site, and in a control site with a similar depth profile and located offshore. Despite a major sewage spill disaster in Suva Harbour in December 2014, the stressed inshore site recorded higher coral species diversity and similar species abundances in comparison to the offshore site. A significant decrease in coral cover was observed between July 2014 (27.10%) to January 2015 (20.33%) in this site, however, no significant decrease was seen in July 2015 (18.47%). Coral spat abundance on artificial substrata (6720 cm2 per site) was similar for both sites except for Family Poritidae; with relatively similar total yearly spat abundance between sites: 106 spat inshore, 132 spat offshore. Annual sedimentation was significantly higher in the inshore site (657.14 grams), compared to the offshore site (371.52 grams). Particulate Organic Matter (POM) was also significantly higher in the inshore location (107.51 grams), and (43.37 grams) for the offshore site. Mean light Intensity was significantly lower for the inshore site (69.81 lum/ft2) compared to the offshore site (239.26 lum/ft2). Mean ambient site temperature was consistently similar for the inshore and offshore sites; 26.87 and 26.86 degrees Celsius respectively.

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CORAL COLONIZATION ON REEF BALLS AT RATATOTOK COASTAL ZONE IN NORTH SULAWESI PROVINCE OF INDONESIA (Abstract ID: 27981 | Poster ID: 668)

Enhancing the produtivity of reef area by using artificial reef methods has been recently used by coral reef aurthorities throughout the world. Such program is also adopted by Indonesian reef communities. Reef Balls deployment was one of some coral reef management activities that being used in Indonesia. Ratatotok coastal area at North Sulawesi Province of Indonesia had been chosen for this program. During 1999 to 2001 a total of 2500 reef balls were laid at the bottom of Ratatotok coastal area. Reef Ball is an artificial reef which was made to closely mimicked the natural hard coral substrate. It was originate by PT Newmont Minahasa Raya to use reef balls to increase the productivity of Ratatotok coastal area. After 15 years, various hard corals were found to attach on reef balls. More then 20 genera of hard corals colonized the reef balls. The diameter of these corals were varied between 10 to more 40 cm. Dominant genera found to dominate in the reef balls were Acropora spp, Porites spp, Gardineroseris sp and Favites spp. Base on the result of this study, it seems that reef balls can be adopted as one of promising artifial reefs chich could be used to recover a damaged reef. Keywords : hard coral, colonization, reef ball

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HARD CORAL CONDITIONS IN RATATOTOK PENINSULA REEF, SOUTH-EAST MINAHASA, NORTH SULAWESI PROVINCE, INDONESIA. (A MONITORING STUDY: 1996-2012) (Abstract ID: 28049)

Since 1996-2012, an intensive monitoring esthablish by PT Newmont Minahasa Raya (PTNMR) to closely monitor the condition of coral reef in the coastal areas of Ratatotok and Buyat bay, South-East Minahasa region, North Sulawesi, Indonesia. In this area, PTNMR a gold mining company was operated in 1996 – 2004 and put its tailing in the seabed of Buyat Bay. One of coral reef monitoring programs is to monitor of hard coral condition. The objective of this study was to describe the hard coral condition before, during, and after PTNMR operation. A Line Intercept Transect (LIT) method was applied for gathering the hard coral data. Fix permanent transects were established in four location at the depth of 3 m and 10 m. All data were collected each year. There were several changes occurred during the monitoring period both on the number of genera of hard coral and the total coverage of hard coral on each study sites. The percentages of hard coral coverage were varied during the whole monitoring years. There are several factor were identified during this study that could be connected to the fluctuation of hard coral conditions. Fish bombing, bleaching (1997, 2010), Crown of Thorn Starfish attacked (1998), bottom gillnetting, and coral disease were major factors that caused the changes in hard coral. However, it can be concluded that beside such destructive factors mentioned above, the hard coral conditions were stable during the whole monitoring years. Moreover, there were no sign that the sediment from the PTNMR operation have influenced the coral condition these areas. Keywords: coral reef, hard coral, ratatotok

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CORAL TRANSPLANTATION ON REEF BALLS AT PUTUS-PUTUS ISLAND COASTAL ZONE, NORTH SULAWESI, INDONESIA (Abstract ID: 29249 | Poster ID: 663)

In 2000 around twenty reef balls were laid at the depth of 8 – 10 m in Putus-pitus Island coastal area. Several little holes were made at each reef ball. Hard coral transplants were attached to these holes. Acropora and Pocilloporids were chosen as transplant considering to their faster growing capabilities compared to other hard corals. Transplants were taken at almost same depths where the reef balls were. The transplant lengths were varied from 5 to 8 cm. At the first ten years 75 % of transplants seemed to grow well. After 11 years the transplants started to die for unknown reason. The Pocilloporids were no more after 12 years. Some table-like Acropora were also started to die and covered by turf algae. After 15 years only three Acropora transplants left. However, these three transplant were succesfully grew. Each of them attained more than 2 m in colony length. All of these Acropora had irregular branch type of growth. As a conclusion, it can be said that Acropora with irregular branch type would adapt perfectly to the reef ball construction. Keywords : reef ball, transpant, Acropora

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CORAL BLEACHING IN RATATOTOK PENINSULA AND ITS SURROUNDINGS AREA, SOUTH-EAST MINAHASA, NORTH SULAWESI PROVINCE, INDONESIA (A 15 YEARS MONITORING DATA) (Abstract ID: 28043)

Ratatotok Peninsula and its surrounding areas are integrated to South-East Minahasa District of North Sulawesi Province, Indonesia. 15 years hard coral and sea surface temperature data were collected respectively. In 1997, 2000 and 2010 the surface temperature was noted to rise about 2 – 3 degree of Celsius. The total coverage of hard corals was declined or tent to decline during those years. Although several other causes, i.e. bombing, poisoning, netting and Acanthaster plancii predation, were found also as reasons for coral destruction, bleaching events that occurred in 1997, 2000 and the latest one was occurred in 2010 could be blame as major factor that ruined the reefs in these area. Nevertheless, not all hard corals were affected. Compared to other Indonesian reef which were also affected by coral bleaching, most of coral genera attacked in this study area was the dominant genera, such as Acropora (at Ratatotok Peninsula and Hogow Island) and Galaxea (at Ratatotok Peninsula). It was very obvious that the bleaching events in those years were corresponded by increasing sea temperature. Sea temperature data were collected by using CTD (Conductivity, Temperature, Depth) data logger. However, after several months, it seemed that almost all of coral suffered from bleaching were survived. Strong current was probably the main key for the corals to survive from those bleaching events. Keywords: coral, bleaching, temperature.

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EFFECT OF MANGROVE FOREST DISTANCE AND FISHING ON THE ASSEMBLAGE OF TARGETED NURSERY REEF FISHES (Abstract ID: 29287)

Expansion in fishing effort and reduction of adjacent habitats, such as mangrove forests, seriously affects fishery catch in the Philippines. As a consequence, catch and abundance of fishes are reduced significantly. This alarming situation prompts initiatives to explore new insights for fisheries management. Small scale fishing gears in the Philippines heavily target fishes at nearshore habitats. Some of these fishes are nursery species, i.e., juvenile fish growing at mangroves to adult size subsequently move to seaward deeper reef habitats. This study examines the effect of fishing and nursery habitat distance on the assemblage of targeted nursery reef fishes in selected Philippine reefs with varying distances from mangrove forests and subjected to various levels of fishing pressure. Both fishery dependent and fishery independent methods were utilized for this study such as survey interview with fishers and fish visual census, respectively. Initial results of the study stress the importance of gear regulation as a simple yet sound basis for sustainable fisheries together with other synergistic management strategy such as protection of the reef-mangrove continuum and considering the presence and proximity of nursery habitats, such as mangrove forests, in designing Marine Protected Areas (MPAs).

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STATE-SPACE MODELLING TO QUANTIFY THE DRIVERS OF CORAL COMMUNITY DYNAMICS OF THE INSHORE GREAT BARRIER REEF (Abstract ID: 28436)

Knowing how different environmental and biological drivers interact to affect coral population abundance trends is critical to understanding the resilience of reefs exposed to multiple pressures. Here, we use a multivariate autoregressive state-space (MARSS) modelling approach based on a density-dependent Gompertz population to model the spatio-temporal trends in coral dynamics for 32 sites sampled over 9 years and spanning ca. 800 km of latitude within the inshore Great Barrier Reef (GBR). The MARSS approach accounts for observational error and environmental stochasticity (process error), while also handling missing values, irregular spaced and autocorrelated data and the high spatial and temporal variation typically encountered in coral community time-series.

A range of MARSS models were fitted, and water clarity and storm history emerged as key drivers of the expected underlying coral cover. The best-fit model also suggested that the dynamics of the 32 reefs was best explained using a spatial population structure of 4 distinct Natural Resource Management regions (NRMs). The underlying NRM-specific coral cover trends revealed 3 distinct spatio-temporal patterns over the 9 year period: high and stable in Mackay, low and stable in Burdekin; and decrease in both the Wet Tropics and Fitzroy regions. The MARSS approach helped to identify the key environmental drivers of coral reef dynamics of the ecologically distinct regions: information crucial for the prioritisation of cost-effective management actions for reefs exposed to regional-specific anthropogenic pressures.

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## USING COASTAL ECOSYSTEM SERVICES TO MITIGATE HUMAN AND CORAL REEF PATHOGENS (Abstract ID: 28411)

Diseases that impact both human and coral reef health represent critical management challenges in rapidly developing coastal environments. To date, natural filtration services provided by seagrass, mangrove and bivalve ecosystems have not been examined as practical management tools for moderating runoff containing pathogens or disease-causing pollutants. Using next-generation sequencing, we present a series of recent studies suggesting seagrass meadows in a densely populated archipelago of Indonesia regulate seawater microbial communities and significantly reduce microbial pathogens implicated in disease causation in humans and numerous coral reef organisms. Parallel field surveys reveal that globally devastating diseases affecting reef-building corals are significantly lower on reefs adjacent to seagrass meadows compared to reefs without seagrass meadows. These results underscore conceivable strategies for mitigating waterborne marine diseases and highlight novel services provided to humans and coral reefs by intact coastal ecosystems.

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## DAMSELS IN DISTRESS: WIDESPREAD DISEASE IN GALAPAGOS REEF FISHES (Abstract ID: 29968)

Emergent disease is one of the less understood but potentially devastating impacts of climate change. Warmer waters have been associated with increased disease and population decline in benthic invertebrates, but less is known of the effects on fish communities. We observed an outbreak of fish disease during the onset of the 2015-2016 El Niño event in the Galapagos Islands, Ecuador. The disease presents initially as discoloration of the skin followed by progressive whitening, loss of scales, and epithelial deterioration. Advanced cases have severe loss of structural integrity and limb function. Infected individuals show abnormal behavior including distressed swimming, lethargy, increased opercular ventilation rates, and aggressive solicitation of cleaner fish. Pathogen isolation is in progress. To date, 16 infected species have been recorded to a depth of 15m on several islands. Prevalence rates vary, but the four most heavily infected species at Cuatro Hermanos Island are the ring-tailed damselfish Stegastes beebei (49.1%), the giant damselfish Microspathodon dorsalis (28.6%), the Panamic soldierfish Myripristis leiognathos (26.0%), and the king angelfish Holacanthus passer (19.6%). Prevalence rates are probably under-estimated as fish with advanced disease likely fall prey quickly to predators. The wide geographic extent (>73 km), high prevalence rates, range of species from vastly different phylogenetic backgrounds affected, and progressive symptoms of the disease present an alarming situation for this diverse and productive fish assemblage with high rates of endemism.

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## CAPACITY DEVELOPMENT FOR PROTECTED AREA MANAGEMENT IN THE PACIFIC (Abstract ID: 27790)

The Pacific Islands Managed and Protected Area Community (PIMPAC) was established in 2005 as a long term capacity development program and social network of site based managers, non-governmental organizations, local communities, federal, state, and territorial agencies, and other stakeholders working together to collectively enhance the effective area-based management in the US Pacific Flag Islands and Freely Associated States of Micronesia. To do this PIMPAC supports capacity building for ecosystem-based management approaches, which integrate land and sea connections as well as human dimensions into management planning and activities. Examples of this scope include ridge to reef management, marine and/or terrestrial protected areas, and community based locally managed areas. PIMPAC's three main goals include: 1) develop model sites that are effectively planned, monitored, evaluated, and managed adaptively, 2) develop jurisdictional teams with core competencies to carry out effective management, and 3) institutionalize trainings in the region to support long term access to skills building for current and future area based managers. PIMPAC uses four types of activities to reach its goals: 1) Training and Technical Support, 2) Learning Exchanges, 3) Partnership Building, and 4) Communications/ Information Sharing. When implementing these activities, PIMPAC focuses on: adaptive management planning, biological monitoring and socio-economic monitoring enforcement, climate change adaptation and watershed management.
http://www.pimpac.org

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## MACRO AND MICRO-SCALE SPATIAL VARIATION IN THE ACOUSTIC ACTIVITY OF SNAPPING SHRIMP ON CORAL REEFS IN THE PACIFIC (Abstract ID: 29218)

Coral reef soundscapes are increasingly becoming recognized as critical factors in the study of reef dynamics, from the role they play in larval recruitment to the assessment of coral reef biodiversity and ecosystem stability. Snapping shrimp produce the predominant source of sound on most coral reefs at frequencies between 2 and 20 kHz. Their activity is influenced by a variety of abiotic factors, including light levels, temperature, and weather. As such, coral reef soundscapes are prone to considerable flux and variation. However, this variation is still poorly understood on a variety of spatial and temporal scales, making it difficult to draw meaningful comparisons between the soundscapes of different reefs. We report on an effort to quantify the acoustic activity of snapping shrimp across twelve coral reef sites in the Pacific Ocean separated by distances ranging from hundreds of meters to thousands of kilometers, including reefs across the Hawaiian archipelago, the Northern Mariana Islands, and American Samoa. We use data obtained from long-term, bottom-moored acoustic recorders to document the variability in snapping shrimp activity observed on multiple temporal scales, ranging from days to seasons, and examine factors correlated with this variability at each location.
http://oceanwidescience.org/coral-reef-acoustic-monitoring/

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## INTEGRATING ECHO-SOUNDER AND UNDERWATER VIDEO DATA FOR DEMERSAL FISH ASSESSMENT (Abstract ID: 29303)

Effective management of demersal fish species requires accurate, spatially explicit assessments of their abundance and distribution. Non-invasive techniques such as echo-sounders and visual census are of particular importance in no-take marine reserves where direct sampling is restricted. This study is investigating the use of echo-sounders and stereo Baited Remote Underwater Videos (stereo-BRUVS) in demersal fish assessment. Echo-sounders have the advantage of covering nearly the entire watercolumn and being able to cover vast areas in a relatively short period. However, "ground-truth" data is usually needed to produce species-specific identification and sampling the area close to the seafloor is problematic, requiring investigation, particularly for demersal species in complex topography. Whereas, underwater video techniques allow identification to species level in most cases, but in a particular location. The combination of co-located bathymetric and habitat maps, with quantifiable acoustic backscatter and species-specific visually groundtruthed abundance, holds potential to significantly further these studies and provide a more cost- and labour-efficient sampling regime. This study provides a preliminary investigation into the relationship between active acoustic and stereo-BRUV derived biomass maps acquired in Western Australia's shallow water reefs and compares the results across various depth strata, bathymetry and habitat.

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FLESHY MACROALGAE SHARE DOMINANCE WITH OTHER ORGANISMS ON DEGRADED CORAL REEFS (Abstract ID: 29985 | Poster ID: 583)

Based on an analysis of 482 Caribbean area sites surveyed by AGRRA in 2011-2013, fleshy macroalgae (FMA) cover exceeded that of all other benthic organisms. Yet FMA dominance (defined as occupying 25% or more of the substratum) was only observed in 60% of the sites. When the cover of calcareous macroalgae is added to FMA, macroalgal (MA) dominance increased to 77% of the sites. Turf algal sediment (TAS) mats, which displace corals and prevent recruitment of coral larvae, were present in 77% of the sites, but only displayed dominance at 10% of sites, mainly at shallower depths (6 vs.12 m) and on patch reefs. Live coral cover only averaged 13% across all sites. The average cover for crustose corallines and sparse turf algae, both ideal coral recruitment surfaces, averaged 20%. Invertebrates that overgrow corals (certain sponges, octocorals, zoanthids, tunicates) were present in most (81%) surveys. Our results support the observation that, organisms promoting reef construction are losing the competition for substratum space on most of these Atlantic reefs. Large-sized herbivorous fishes offer one of the only natural ways to remove MA holdfasts but will avoid TAS mats. While bans on harvesting parrotfish are a sensible component of biologically-based management, recovery or restoration of sea urchins may be more important. In heavily fished reefs, physical removal of MA, and/or reduced nutrient and sediment inputs to nearshore reefs might also be needed to discourage the growth of undesirable benthic algae.

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EVIDENCE OF THREE LEVEL TROPHIC CASCADES WITHIN REEF FISH ASSEMBLAGES FROM BODY-SIZE DISTRIBUTIONS (Abstract ID: 29367)

Assemblage body-size distributions can provide information on the ecological processes that structure ecosystems. Fishing can restructure marine ecosystems by directly removing large individuals, thereby indirectly reducing predation pressure on medium bodied individuals (prey of larger bodied species) and increasing their density. We compared assemblage body-size distributions sampled using baited underwater stereo-video inside and outside areas closed to line fishing at the Houtman Abrolhos Islands off Western Australia over three years. Both spline based Functional Data Analysis and multivariate analysis of size bins found significantly lower proportions of large and small body-size species and a greater abundance of medium body-size species at fished sites relative to those closed to fishing. Within this study, metrics based on body-size appear to be much more sensitive to the effects of fishing than metrics based on abundance or biomass of particular species. Obtaining reliable body-size information is an important consideration in studies investigating the effects of fishing on reef fish assemblages.

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GUAM'S STAGHORN ACROPORA POPULATIONS REQUIRE MANAGING FOR RESILIENCE (Abstract ID: 29488 | Poster ID: 169)

Guam's coral reefs were severely impacted from back-to-back bleaching episodes in 2013 and 2014. Surveys in 2015 estimated that 47% (+/- 10%) of Guam's staghorn Acropora were lost to bleaching-related mortality within 12 months. This constitutes the loss of over 18 ha of coral dominated by four species: Acropora muricata, A. aspera, A. c.f. intermedia, and A. c.f. pulchra. Staghorn Acropora were found at 21 sites and half of these sites lost ≥75% of their cover; others have been reduced to small, scattered clumps. Efforts to manage for future resilience have begun. The reproductive biology of this group has not previously been studied in Guam and this is the current focus of these efforts. Preliminary results suggest that, in 2015, A. c.f. intermedia spawned in April, A. cf. pulchra and A. muricata spawned in May, and A. aspera spawned in September. Genetic analysis is in progress to examine connectivity between remaining staghorn populations. Additional current management efforts include culturing of asexual fragments from surviving communities and reintroducing them to decimated areas. Understanding the reproductive biology, genetic structure of remaining populations, and the relative roles of both asexually- and sexually-produced colonies in natural populations are all critical to effectively managing and re-establishing Guam's staghorns.

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CORAL RECRUITS ON PALMYRA ATOLL EXHIBITING 'STRANGER DANGER' (Abstract ID: 28745)

Corals are sessile animals that form some of the most biodiverse regions in the world. Since these animals are usually found growing on a piece of hard substrate, they search for cues before settlement as planktonic larvae. These animals have been known to show density dependent recruitment, and one species *Montastrea faveolata* shows a Janzen-Connell effect where young individuals do not mix with adults to escape bacterial and other conspecific related diseases. This information thus spurs the question do coral recruits show density and distance dependent recruitment towards other recruits? In order to answer this question photomosaic analyzing techniques were used to find average distances between all known coral recruit genera at three sites on Palmyra Atoll. It was found that each genera has their own specific bias, showing clustering when compared to certain species but over-dispersion towards others. These findings are also heavily skewed by population size since the genera compared were found at vastly different densities. In the future including studies of adult distances to juveniles conspecifically would potentially provide information on possible Janzen-Connell effects.

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A TALE OF TWO OCEANS: ARE DEEP-SEA BAMBOO CORALS FUSSY ABOUT THEIR NEIGHBORS? (Abstract ID: 27823)

Bamboo corals (Family Isididae) are a widely distributed group of gorgonian octocorals, with the subfamily Keratoisidinae commonly found in the deep sea below 200 m. High-definition in situ images, video footage, literature, and collected specimens were used to characterize the benthic megafauna communities on seamounts off Tasmania in the South Pacific and on the New England and Corner Rise Seamount chains in the Northwest Atlantic. The overall benthic community structure is strikingly different between the two locations. However, a detailed taxonomic analysis of the bamboo corals collected suggests that a few of the species present on Tasmanian seamounts are very closely related to, and perhaps the same species, as specimens collected from the Northwest Atlantic seamounts. These results support the individualist theory of ecology and imply that the environmental conditions in these two regions, although in two different oceans and on opposite sides of the globe, are favorable for the settlement and growth of these particular species of bamboo corals, independent of their surrounding neighbors.

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MODELLING CORAL PHOTO-PHYSIOLOGY AND GROWTH POTENTIAL UNDER VARYING TURBIDITY REGIMES (Abstract ID: 28292)

Management of dredging typically relies on suspended sediment thresholds. When sediment thresholds are exceeded, the risk of damage to corals is elevated and dredging activities are suspended. Yet, most threshold values are based on limited biological data, are not site specific, and are typically linked to coral mortality not stress. To provide more effective management of reefs vulnerable to high sediment loads, a numeric model was developed based on site-specific biological (photosynthetic yield, P-I curves) and physical data (light attenuation, turbidity). The model quantifies zooxanthellae and coral growth potential (mass carbon) under varying light-turbidity regimes, and incorporates coral acclimation to low light over time following increases in zooxanthellae biomass. A high growth potential indicates a non-stressed coral with energy for essential functions (e.g. feeding, reproduction). The model (2D FM model with ECO Lab; MIKE, DHI 2012) was run for two weeks under four light-turbidity regimes (< 5, <20, <45, >100 mg/l) for Platygrya sinesis, a common clear and turbid water coral. The model output indicates that at <20 mg/l, both zooxanthellae (100-150%) and coral (18-50%) growth potential is high. However at >45 mg/l low light availability results in a negative scope for growth with no photo-acclimation occurring at the highest turbidities. Our study provides a critical step towards a comprehensive model that, together with site specific data, can be used as a quantitative tool to both track and forecast the potential effects of high sediment loads on corals.

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CARIBBEAN OCTOCORAL COMMUNITY DYNAMICS: REGIME CHANGE, STABLE STATES OR JUST THE LAST COLONY LEFT STANDING? (Abstract ID: 29089)

Descriptions of the transition of tropical reefs from dominantly scleractinian cover to other taxa have overwhelmingly focused on the well documented loss of scleractinians in favor of macroalgae. However, reports from both Caribbean and Indo-Pacific reefs have documented cases of increased abundances of taxa such as sponges, zoanthids, corallimorpharians, or octocorals. In most cases, the basis for these transitions is unknown, but it is clear that the trajectories of other macro-invertebrate populations, when known, are different from those of both scleractinians and macroalgae. Focusing

on Caribbean octocorals we explore 3 classes of hypotheses for why some non-scleractinian taxa have increased in abundance. 1, Scleractinians and octocorals compete for space and the competitive balance has changed; 2, Octocorals are more resistant to environmental challenges than scleractinians; or 3, Octocoral populations are more resilient than scleractinians, which can be subdivided to 3a, octocoral populations recover more rapidly and preempt scleractinian recovery, and 3b, octocorals are less affected by, and benefit from, feedbacks between community change and recruitment that have limited the resilience of scleractinians. Data to rigorously test these hypotheses are not available but decadal scale data from two Caribbean locations suggest that the resilience of octocoral populations may be a key component of observed changes in abundance.

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THE RELATIONSHIP BETWEEN BEHAVIOURAL AND PHYSIOLOGICAL TOLERANCE TO ELEVATED CO2 IN CORAL REEF FISH (Abstract ID: 29351)

Reef fish exhibit individual variation in both behavioural and physiological sensitivity to elevated CO2. Those individuals that are most tolerant provide hope for future populations to adapt to changing environmental conditions. Yet whether there is an interaction between behavioural and physiological tolerance is unknown. We seek to understand this relationship, as well as how elevated temperature might alter it. Juvenile Acanthachromis polyacanthus will be reared in one of four temperature x CO2 treatments: control, elevated temperature, elevated CO2, or elevated temperature and CO2. After 40 days individuals from each treatment will be tested for their behavioural and physiological tolerance to elevated CO2. Behavioural tolerance will be measured as response to chemical alarm cue in a two-choice flume tunnel. Physiological tolerance will be measured as aerobic scope in a respirometer. We predict that a tradeoff will exist between behavioural and physiological tolerance to CO2, where individuals with a high behavioural tolerance will have a low physiological tolerance, and vice versa. This indicates that at the population level, selection towards highly tolerant individuals will act orthogonally to the direction of the most genetic variation, and so future adaptation to high CO2 conditions will be constrained. Furthermore, we predict that elevated temperature and CO2 together will have a multiplicative effect on physiological tolerance. This will increase the importance of behavioural tolerance, and thus push future populations towards an increased behavioural tolerance.

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FINDING A BIOLOGICAL UPPER LIMIT FOR THE MESOPHOTIC ZONE (Abstract ID: 28599)

The lower boundary of the mesophotic zone on coral reefs is largely accepted as coinciding with the last photosynthetic hard corals. The upper limit is set at 30m. These two boundaries are fundamentally different in character. The lower bound is capable of moving, accommodating changes between sites in water clarity and local species capabilities. Such a mobile boundary allows the logical comparison of mesophotic reefs from different sites based on their biology. The upper bound, as currently defined, is a more limiting concept. Generally there is greater environmental variability in the shallows than at depth. This variability could cause the upper limit to vary from site to site. A fixed upper limit may lead to illogical comparisons between sites across reef zones. Here it is argued that we should try to reach a consensus on an upper limit of the mesophotic zone, rooted in biology, allowing the easy identification of mesophotic reefs by researchers. Potential defining characters may include irradiance levels, changes in physiology or taxonomic indicators. Here we propose using benthic community composition. Coral presence or absence as a signal integrates many environmental variables which may reveal the boundaries of mesophotic reefs. Identifying corals visually may also be faster and require less specialist equipment than other approaches. Data from Honduras is used to show vertical reef structure if we take a lead from community data. An in progress follow up project employing a systematic review to capture the global picture will also be explained.

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GROUPER CATCH TRENDS (1950S TO 2014) IN FIVE MARINE KEY BIODIVERSITY AREAS INFERRED FROM FISHERS' KNOWLEDGE USING LINEAR MIXED METHODS (Abstract ID: 28046 | Poster ID: 10)

We analyzed fishers' knowledge data(n=1245) on ten groupers species from 1950s to 2014 in 5 marine key biodiversity areas(mKBA) in the Philippines, including Lanuza Bay, Danajon Bank, Verde Island Passage, Polillo Islands and Honda Bay using Generalized Linear Mixed Modelling to determine the catch per unit effort(CPUE) declines of each grouper species throughout the decades. Fixed effects included effort variables such age, gear, horsepower and hours fishing, while random effects included the interviewee, age and mKBA. Life history metrics such as maximum total length, growth coefficient, and age at maturity were also modeled to determine which were better predictors of CPUE. Dispersion and Akaike Information Criterion were the criteria for model selection. Groupers including *Epinephelus lanceolatus*, *Plectropomus leopardus* and *Epinephelus polyphekadion*, among others exhibited 34-74% CPUE decline accompanied by a 29-73% decline in the size of fish caught since the 1950s, with *E.lanceolatus* exhibiting the highest CPUE decline.Life history analysis showed that groupers with lower growth coefficient appear to be preferred by fishers. This provides evidence on catch declines throughout the decades and its possible drivers of depletion which may be useful in reassessing local and national policies on small scale grouper fisheries, which includes updating the National Biodiversity Strategy and Action Plan 2016-2028. Marine protected area networks should also be strengthened to encompass the ontogenetic habitats of species,specifically groupers.

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RESPONDING TO WIDESPREAD REEF FINFISH EXTIRPATIONS IN THE PHILIPPINES INFERRED FROM ORAL HISTORY AND FISHERS' KNOWLEDGE USING LINEAR MIXED MODELS (Abstract ID: 27938)

While the Philippines is known to have the globally greatest number of shorefish species with very high fishing pressure, yet no long-term reef fisheries data are available to explore species-level changes that may have occurred widely. Through oral history with 2655 face-to-face interviews, we studied fishers' recall of past catch rates of reef-associated finfish species from Lanuza Bay, Danajon Bank, Verde Island Passage, Polillo Islands and Honda Bay. We modeled temporal trends in catch per unit effort (CPUE) based on fishers' reports of typical good days' catches. Sixty-five different finfishes were reported by fishers to have disappeared from catches between the 1950s and 2014. The five species common to all sites with the greatest number of fishers targeting or opportunistically catching them and reporting zero catches, and with greatest species intrinsic vulnerability index values, were *Bolbometopon muricatum*, *Cheilinus undulatus*, *Alectis ciliaris*, *Epinephelus lanceolatus* and *Lutjanus argentimaculatus*. Our models show that between the 1950s and 2014, the perceived CPUE of bumphead parrotfish declined by 88%, that of humphead wrasse by 82%, African pompano by 66%, giant grouper by 74% and mangrove red snapper by 64%. Using fishers' knowledge and oral history in this data-poor setting, we identify reef fish species vulnerable to local extinction. Among the country's responses to prevent such species loss includes updating the National Biodiversity Strategy and Action Plan 2016-2028 and strengthening of marine protected area networks in marine key biodiversity areas.

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THE ROLE OF NUSA PENIDA MPA IN MANTA RAYS CONSERVATION AND TOURISM WITHIN THE LESSER SUNDA ECOREGION (Abstract ID: 27781)

Nusa Penida Marine Protected Area (20,057.2 ha) is located in southeastern Bali Island of Indonesia. It is one of the most dense marine resource users in the southwest corner of the 'Coral Triangle' by welcoming 200,000 visitors annually. Nusa Penida waters encompass critical habitats for unique marine species such as manta rays and sunfishes. Manta rays (Manta birostris and M. alfredi) have been assessed as vulnerable species according to IUCN Red List, and recently have been protected under Indonesian government law since 2014. The economic value created through visitors in Nusa Penida spend their money nearly USD 2 million annually. However, manta tourism has to become more sustainable in terms of manta life span and their habitats, as well as economic

value to the people. Based on the photo identification, 512 individuals of manta rays have been counted within the Nusa Penida MPA since 2012. Some of them even have been sighted 450 km away, in Komodo National Park. Major threats that need to be addressed include illegal fishing and bycatch, marine debris and massive tourism on manta sighting. This means connecting MPAs in order to protect their migration habitats plays an important role in manta conservation, and a MPA network based on marine connectivity studies is needed. Therefore, it is necessary to link Nusa Penida MPA and some MPAs along the south coast of the Lesser Sunda Islands as one cluster of MPAs network. This paper attempts to describe manta ray issues and the role of Nusa Penida MPA to support manta ray protection within the Lesser Sunda Ecoregion.

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### HIGH PCO2 AND WARMING ARE THREATS FOR THE PEARL OYSTER PINCTADA MARGARITIFERA AND THE PEARL FARMING. (Abstract ID: 28220)

The pearl culture is one of the most lucrative aquacultures worldwide. In South Pacific area, it depends on the exploitation of the pearl oyster Pinctada margaritifera and relies on the environmental conditions of lagoons. It is fundamental to assess climatic stressors, such as ocean acidification and the warming on the functionality of the resource. The impact of pCO2 (3540, 1338 and 541µatm) was evaluated twice on pearl oysters exposed for 100 days on shells by optical and electronic microscopy, and at molecular level by measuring the expression of mantle genes involved in the formation of calcite and aragonite. The impact of temperature (22, 26, 30 and 34°C) was studied on the metabolic capabilities biomineralization on pearl oysters exposed 10 days. High pCO2 (3540 µatm) significantly slowed down the shell deposit rate at the ventral side andthe expression level of Pmarg-PUSP6 gene. SEM observations found chemical dissolution signs. Thirty degree Celsius was the temperature where energy metabolism and, hence, the scope for growth, wasmaximizedthen dramatically fell at 34°C. Biomineralization examined through the expression measurement of mantle genes showed significant changes of Pmarg-NacreinA1, Pmarg-MRNP34, Pmarg-Prismalin14 and Pmarg-Aspein. These changes showed that expression of these genes was maximum at 26°C and minimum at 34°C. The responses to high pCO2 and high temperatures, according to the Intergovernmental Panel on Climate Change (IPCC) projections, highlighted that pearl oyster stocks and cultures would be severely threatened in the next decades.

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### QUALITY OVER QUANTITY: HABITAT CONDITION IS A STRONGER DRIVER OF FISH BIOMASS ON CORAL REEFS THAN HABITAT SPATIAL EXTENT AND CONNECTEDNESS IN THE PHILIPPINES (Abstract ID: 28973)

There is increasing research emphasis on optimising the placement of no-take marine reserves (NTMRs) to maximise their conservation and fisheries benefits. Recently, spatial analysis tools have been used to demonstrate that spatial characteristics such as the extent, proximity, and connectedness of key reef and non-reef habitats can be important drivers of reef fish abundance. In this study, we used a combination of in situ assessment of benthic habitat condition and remote sensing of habitat spatial characteristics to identify the most important drivers of the presence and biomass of six key foodfish groups both inside and outside NTMRs in the central Philippines. We found that spatial variables such as the extent of coral reef, the extent of seagrass beds, and the connectedness of sites with mangrove stands were rarely significant drivers of fish presence or biomass, regardless of the fish group's known habitat uses. Instead, measures of benthic habitat condition or suitability such as depth and percent cover of benthic components specifically required by each fish group were consistently better predictors of both foodfish presence and biomass. NTMR status was also a key predictor of foodfish biomass for 5 of 6 fish groups, and a key predictor of foodfish presence for 3 of 6 fish groups. Our results highlight the value of NTMRs in this system, and underscore the importance of placing NTMRs in high-quality benthic habitats to ensure their conservation and fisheries objectives can be achieved.

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### ECOSYSTEM VULNERABILITY AND CUMULATIVE IMPACTS ON HAWAIIAN REEFS (Abstract ID: 29168 | Poster ID: 596)

The nearshore reef environment in Hawai'i is impacted by a wide range of human activities. As a result of these anthropogenic drivers, economic and sociocultural benefits to communities in Hawai'i have diminished over time. Understanding the spatial distribution, intensity, overlap, and cumulative impact of human activities is essential for effective marine management and protection of ecosystem services generated by coral reefs. Currently, this kind of information is not readily available to resource managers and policy makers in Hawai'i. This research uses existing data and novel approaches to produce maps for some of the most important anthropogenic drivers of coral reefs in Hawai'i. To accomplish this, we compiled a comprehensive database, synthesized a suite of spatial datasets into a unified framework, and devised geospatial methodologies to produce statewide maps of anthropogenic drivers including: fishing pressure, land-based pollution, habitat modification, and invasive species. Expert knowledge surveys were conducted to assess the vulnerability of different habitat types to anthropogenic drivers. The resulting vulnerability weighting factors for stressor-habitat pairs were used to produce continuous maps of cumulative impacts across the Main Hawaiian Islands. These maps directly benefit management by identifying what places and habitat types are most impacted, which drivers should be of greatest concern in different areas, and where different management strategies (e.g. regulations, restoration, enforcement, or increased monitoring) should be prioritized.
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### CELL PROLIFERATION AND TURNOVER IN EARLY LIFE STAGES OF A SYMBIOTIC SCLERACTINIAN CORAL (Abstract ID: 28687)

Cellular dynamics underlying scleractinian coral metamorphosis and growth of the primary polyp remain largely unknown, limiting our understanding of this critical phase in the life cycle. In this study, we investigated coral and endosymbiont cell proliferation while simultaneously recording TUNEL-positive apoptotic cells in four life stages (planula, early metamorphosis, primary polyp and adult colony) of Stylophora pistillata (Esper, 1797). The fate of BrdU-labeled cells was monitored in the developing primary polyp over a 3 d period. The highest proliferation activity was localized in the pharynx area. During the chase period, BrdU-labeled cells accumulated in the surface pseudostratified epithelium and the skeletogenic calicoderm of the primary polyp. Surprisingly, the lowest cell turnover was always recorded in the calicoderm, despite active, ongoing skeletal deposition following settlement. Furthermore despite a constant symbiont to host cell ratio, the dinoflagellates had much higher DNA synthesis rates compared to the coral gastroderm cells, especially during planula and early metamorphosis stages. Apoptosis in the symbiont population shifted from low rates in the larval stages to high rates in the developing primary polyp. These results highlight an ontogenic succession of post-mitotic control mechanisms by the host of its endosymbiotic Symbiodinium sp. population.

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### PROPAGATION OF SEDIMENT IMPACTS IN AN ECOLOGICALLY IMPAIRED REEF SYSTEM (Abstract ID: 28572)

Suspended sediment and sedimentation are some of the greatest threats to coral reefs, and these are expected to worsen with increasing land use and growth of coastal populations. Conditions of high suspended sediment concentration and sedimentation significantly alter the physical structure of coral reefs. Coral distribution becomes vertically truncated with light attenuation, often with the replacement of reef slope habitats with silts, and rugosity is further reduced with loss of topographically complex sensitive taxa. This severely reduces ecological function of coral reefs, especially impairing physical processes such as energy attenuation and in turn affecting sediment transport. Using a combination of acoustic and optical instruments, the sediment transport characteristics in complex flow around reefs are described. We demonstrate that low complexity, silted reefs in Singapore, typically considered as ecological receptors in impact assessments for activities such as dredging, can also function as a novel source of sediments to other habitats. Recursive settlement, resuspension and transport sets up a stepping-stone effect, propagating sediments in space- and time far beyond typical expectations of

point sources in an accumulatively exacerbated manner. This potential roll-on effect from levels of reef impairment that might be within environmental quality objectives of stakeholders in the EIA process emphasizes the importance of considering the fate of transport characteristics of sediment.

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INFLUENCE OF CLIMATE VARIATIONS ON CORAL REEF (CHUUK ATOLL) ACIDIFICATION IN THE WESTERN PACIFIC OCEAN (Abstract ID: 27944)

The primary goal of the present study was to explore the effects of large-scale climate variations on the physical and biological processes that determine carbonate chemistry of reef waters. The 7-year weekly records of carbonate chemistry conditions in the Chuuk lagoon, located in the coral-rich western Pacific Ocean, showed that during weak intrusion of ambient seawater from the surrounding open ocean two internal biological processes (calcification and respiration) reinforced each other and collectively lowered the pH of the reef water for extended periods, ranging from a few to several months. Our study indicates that periods of low wind speeds weaken the intrusion of ambient water, resulting in a longer residence time of reef water so that respiration and calcification increase its acidification. This finding is not an isolated phenomenon, but may be widespread in the coral-rich western Pacific Ocean, which contains 50% of global coral reefs and in which the degree of ambient water intrusion was found to be closely associated with the El Niño Southern Oscillation-induced wind speed change.

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THE ROLE OF THE SEA CUCUMBER HOLOTHURIA SCABRA AS A CORAL REEF ECOSYSTEM ENGINEER IN FIJI (Abstract ID: 28153)

A substantial amount of organic matter (OM) on coral reefs is mineralized in permeable sands. Bioturbation through reef ecosystem engineers such as sea cucumbers can potentially enhance recycling of OM in reef sands. However growing demand from Asian markets has driven the overexploitation of sea cucumbers globally. Thus there is a pressing need to understand the consequences their removal has on reef ecosystems. Densities of Holothuria scabra were manipulated in enclosures in situ on a reef flat in Natuvu, Fiji, to simulate different fishing intensities. Three treatments (n=4 treatment-1) were used; High (350g m-2), Natural (60g m-2), and Low (0 g m-2) density of H. scabra, and Cage controls. Sedimentary oxygen consumption (SOC), organic carbon turnover, grain size distribution, porosity, and O2 penetration depth were recorded. Additionally feeding rate, burrowing rate, and sediment reworked were quantified in relation to H. scabra size class, microhabitat, tidal cycles, and diurnal cycles. All parameters are combined to provide a more comprehensive view of the ecosystem role of H. scabra. Preliminary results show that natural density enclosures and cage controls were similar. SOC rates were consistently higher in low-density than high-density enclosures. This indicates that bioturbation by sea cucumbers plays a significant role in the capacity of reef sediments to recycle OM. Overfishing of sea cucumbers may thus lead to a reduced ability of reef sands to process OM pulses caused by land-derived eutrophication and thereby decrease the overall resilience of local reefs.

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CARIBBEAN CORAL REEF BASELINES FROM AN ARCHAEOLOGICAL PERSPECTIVE: PROSPECTS AND CHALLENGES FOR INTERDISCIPLINARY STUDIES AND CONSERVATION EFFORTS (Abstract ID: 29996)

Within the interdisciplinary study of marine historical ecology, practitioners have argued for the importance of historical baselines to inform coral reef conservation efforts throughout the world. Research has demonstrated the great temporal depth of anthropogenic and environmentally-derived changes among coral reef habitats, and has provided chronological context to current coral reef conditions and projected futures. However, in many cases, the full potential of historical coral reef baselines is yet to be realized in terms of collaborations that present multi-dataset perspectives of coral reef deep history. In this presentation, we discuss some of the challenges of constructing critical temporal baselines from an archaeological perspective, focusing on the Caribbean Antilles. Drawing on illustrative case studies, we summarize archaeological evidence of coastal resource utilization and examine the potential and limits of archaeological data for constructing baselines. Considerations include analytic scale, chronological control, sampling, and cross-disciplinary dataset integration with historical, paleontological, and modern data. We argue greater emphasis needs to be placed on interdisciplinary studies that parse anthropogenic from environmental change in coral reef ecosystems through time, while recognizing such changes are not necessarily mutually exclusive. Increased interdisciplinary collaborations of this nature in the Caribbean region will better serve conservation efforts.

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INFLUENCE OF FUNCTIONAL TRAITS ON THE PERCEPTION OF CORAL REEF FISH BIODIVERSITY PATTERNS. (Abstract ID: 28077 | Poster ID: 503)

An increasing body of literature suggests that functional diversity enhances ecosystem functions such as productivity, resilience to disturbances or invasions and regulation in the flux of matter. Numerous indices are now commonly used for assessing functional biodiversity. They are mainly based on the values of functional traits taken by the species in the community studied. However, the impact of functional traits on the assessment of functional indices, and thus on our perception of functional diversity patterns, is still poorly known. Here, we presented the first study strictly focused on the sensitivity of the most used functional indices to the variation of the number and the nature of functional traits. We used data on coral reef fish's communities collected by underwater visual census in Tuamotu Archipelago (French Polynesia) to raise this issue. We found not only that the number and the nature of functional traits may strongly alter the estimation of the indices considered but it may also lead to counter-intuitive results. Moreover, we showed that the extent and profile of the sensitivity of functional indices to the number of functional traits strongly vary from one index to another. In fine our results highlight that the properties of functional traits may have huge consequences on functional diversity assessments and management decisions.

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THE DYNAMIC CHANGES OF REEF CORALS IN THE XUWEN CORAL REEF RESERVE AREA DURING THE PAST TEN YEARS (Abstract ID: 29213 | Poster ID: 63)

Xuwen coral reef was the only largest fringing reef in the mainland China. The status of the coral reef in Xuwen coral reef reserved area was investigated from 2004 to 2014, and the total recorded species number was 62 in 11 families and 29 genera. Over the past 10 years, the coral community in the reserved areas showed a great trend of degradation, and the main type of coral species were massive, while branching coral species becoming increasingly rare since 2004. The total recorded number of reef coral species in the area decrease from the highest of 54 to recent of 20, and the average living coral coverage dropped from 28.9% to about 10%. The factors impact on this coral reef reserved area were very complex, among which the human fishery activities and intensive aquaculture being the most important factors. We suggested that the ecological status of coral reefs in the whole reserved area will be better if the long-term ecological monitoring and human activities management were strengthened.

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SUPPORTING THE HOLOGENOME THEORY OF EVOLUTION: BROADCAST SPAWNER CORAL HAS DIFFERENT STRATEGIES TO TRANSFER THEIR BACTERIA AND ZOOXANTHELLAE (Abstract ID: 29405)

The Hologenome Theory of Evolution (HTE) proposes that host and microbiota genomes are adapted and evolved together as a unit of natural selection. In this case, the microbiome can be transmitted from one generation to the next and, thus, may also influence the evolution of the holobiont. Strong evidence of microbial vertical transmission (VT) in brooding corals was reported in early larval stages of brooder corals and one broadcast spawner. To explore the VT hypothesis, colonies of the broadcast spawner species, *Mussismilia hispida*, were kept in nurseries until spawning. Gamete bundles, larvae and adult corals were analyzed to identify their microorganisms' composition and location. The ultra-thin section transmission electron microscopy showed *Symbiodinium* cells in oocytes but no bacterial profiles were detected, indicating that only the zooxanthellae were transmitted directly from parental to the offspring. In addition, this community was able to change, since parental colonies and oocytes had*Symbiodinium* clades A, B and C, but only clade B was found in the larva. The core bacterial communities found in the bundles, larva, and parental colonies were *Burkholderia, Pseudomonas, Acinetobacter, Ralstonia, Inquilinus and Bacillus*, suggesting that these communities could be vertically transferred through the mucus. These data confirmed the vertical transmission assumption stated in the HTE, also pointing at groups most likely related to coral larvae and adult development, opening the discussion on its potential role in coral resilience.

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IMAGING THE UPTAKE OF NITROGEN-FIXING BACTERIA INTO LARVAE OF THE CORAL ACROPORA MILLEPORA (Abstract ID: 27873)

Diazotrophic bacteria are instrumental in generating biologically-usable forms of nitrogen by converting abundant dinitrogen gas (N2) into available forms, such as ammonium. While nitrogen is crucial for coral growth, direct observation of associations between diazotrophs and corals has previously been elusive. We applied fluorescence in situ hybridization (FISH) and nanoscale secondary ion mass spectrometry (NanoSIMS) to observe the uptake of 15N-enriched diazotrophic Vibrio sp. isolated from Acropora millepora into conspecific coral larvae. Incorporation of Vibrio sp. cells was observed in coral larvae after 4-hour incubation with enriched bacteria. Uptake was restricted to the aboral epidermis of larvae, where Vibrio cells clustered in elongated aggregations. Other bacterial associates were also observed in epidermal areas in FISH analyses. Although the fate and role of these bacteria requires additional investigation, this study describes a powerful approach to further explore cell associations and nutritional pathways in the early life stages of the coral holobiont.

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SEAHARMONY: AN INNOVATIVE FORUM FOR COLLABORATIVE NETWORKING (Abstract ID: 28033 | Poster ID: 707)

seaHarmony is a web-based collaboration network that directly links ocean science researchers with educators, managers, traditional practitioners, artists, and communicators to help them form successful collaborations. The connections are made using compatibility algorithms based on member collaboration interests and preferences that help define the partnership framework. Ocean science professionals can also post announcements, share resources, and ask questions about specific ocean science topics, as well as explore posted ideas or opportunities for collaboration, such as grant proposals, internships, workshops, or public events. A primary goal of seaHarmony is to help ocean scientists interested in broadening the impacts of their research find potential collaborators in education, management, media, or community engagement. Created by COSEE Island Earth, seaHarmony was launched in Hawaii in 2013, expanded nationally in 2014, and is now available to users globally in over 240 countries. This poster will describe key features of seaHarmony, present current data on its usage, and explore further functionalities to better serve the coral reef research community.
http://www.seaharmony.org

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CORAL REEF DRAG COEFFICIENTS – WATER DEPTH DEPENDENCE (Abstract ID: 27960 | Poster ID: 399)

A key physical characteristic of shallow coral reefs is that they are rough, resulting in large drag that limits the strength of the flow across the reef. The flow is a key factor determining the exchange of water and constituents between reefs and the surrounding ocean, the residence time of water on the reef, and exchange between seawater and the coral bed. These physical factors, in turn, influence a variety of physical and biogeochemical processes that impact coral reef ecosystems such as the supply and uptake of nutrients and the thermal environment. Consequently, drag coefficients, relating the flow to the drag, are a critical input for accurately modeling coral reef systems that is poorly constrained with estimates spanning two orders of magnitude. We test the hypothesis that the wide range of drag coefficients is due, in part, to variations in water depth using observations from three different coral reefs (Red Sea, Palau, Dongsha Atoll) and a previous laboratory study. The estimated drag coefficients for depth-average flow from the field observations and laboratory study range from 0.01 to 1 and depend primarily on water depth. Drag coefficients increase as water depth decreases consistent with simple theory from open-channel flow. Hydrodynamic roughnesses over the coral reefs examined generally fall in a relatively narrow range from 2 – 10 cm. Clearly, knowing the dependence of drag coefficients on water depth is critical to understanding the impacts of sea level rise on reefs.

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REVISITING THE IMPACTS OF BLEACHING ON THE REPRODUCTION OF THE STONY CORAL *MONTIPORA CAPITATA* (Abstract ID: 29026 | Poster ID: 172)

Coral reefs in Hawai'i suffered two consecutive major bleaching events in 2014 and 2015 as a result of sea surface temperatures (SST) that, in places like Kāne'ohe Bay, O'ahu, exceeded 27°C for 8 weeks and 15 weeks, respectively. In 2014, up to 73% of the corals on reefs in Kāne'ohe Bay bleached or paled and all dominant coral species displayed high levels of intraspecific variation in their bleaching responses. This allowed neighboring bleached and non-bleached individuals of *Montipora capitata* to be identified and tagged in 2014, so that in 2015 the size and number of eggs per bundle released in the field by these corals could be assessed. All tagged corals released egg-sperm bundles during the June, July, and August 2015 spawning season. There was no difference in the size and number of eggs per bundle released by bleached and non-bleached colonies; however, 40% more eggs were released in egg-sperm bundles in June as compared to July and August, and these eggs were 14% smaller. In July and August 2015, mean SST exceeded seasonal norms by 2°C and the 2015 bleaching event began. A comparison of the 2015 spawning data with 2005, 2007, and 2008 reveals that 2015 eggs were significantly larger and significantly fewer eggs were packaged in each bundle. These bleaching events provide an unprecedented opportunity to examine the long term implications of repeated bleaching on the reproductive success of corals, and in this long-term study, tagged *M. capitata* will continue to be monitored through the 2016 reproductive season and beyond.

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HIGH RESOLUTION GEOCHEMICAL ANALYSIS OF MASSIVE PORITES SP. CORALS FROM THE GREAT BARRIER REEF; RARE EARTH ELEMENTS AS INDICATORS OF VARIABLE TERRIGENOUS INPUT (Abstract ID: 28546)

Rapid land clearing for agriculture and coastal development since European settlement on the Queensland coast of Australia has brought into focus the magnitude of increased sediment load and turbidity delivered to inshore coral reefs on the Great Barrier Reef (GBR). However, quantifying changes in sediment flux to reefs is problematic as instrumental records are spatially and temporally limited. Long lived, annually banded massive corals provide a unique opportunity to reconstruct environmental conditions prior to instrumental monitoring because coral skeletons sequentially incorporate geochemical signals that reflect ambient seawater conditions during growth. A currently under-utilised suite of elements in coral geochemistry includes the rare earth elements (REE), of which ~90% are derived from suspended and dissolved riverine input in coastal oceanic waters. Here we present monthly resolution REE data from four modern Porites coral cores across a known water quality gradient from the Wet Tropics region of the GBR. We compared our results to local river discharge data to evaluate the potential of REEs as a proxy for terrigenous input. We show that monthly resolved time-series of total REE (ΣREE) concentrations in corals reliably record sediment flux associated with river discharge events at inshore locations. Our data also indicates that ΣREE concentrations are up to

three times higher at inshore locations compared to the mid-shelf and that ΣREE concentrations associated with river discharge events have increased two-fold since ~1950.

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CARBONATE DYNAMICS OF AN ALGAL RIDGE (Abstract ID: 29798)

This study aims to clarify the processes producing cementation on and within tropical algalridge environments. Specifically we aim to determine: 1) whether net calcification is occurring atop the algal-ridge on a diurnal timeframe; 2) the redox nature of the algal-ridge framework interior; 3) if sulphate reduction is driving ridge cementation; and 4) the stoichiometry and rate of carbonate calcification and dissolution reactions on/within the algal ridge. We will use state-of-the-art high precision isotope dilution inductively coupled plasma mass spectrometry techniques to analyse small anomalies in [Ca2+] and [Mg2+] (<0.4 µML-1 and <3 µML-1 respectively). We will test the hypothesis that despite ocean acidification (OA) algal ridges are still undergoing cementation. Within the ridge framework we expect the remineralisation of high Mg-calcite (HMC) into more stable carbonate minerals (calcite or dolomite) to be driven by the reduction of sulphate. This would imply that reefs with HMC algal ridges are less susceptible to OA than previously thought.

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IMPACT OF NUTRIENT, SEAWAGE AND CONTAMINANT PRESSURES ON THE WATER QUALITY OF A FRENCH POLYNESIAN REEF LAGOON (FAAROA, RAIATEA ISLAND) (Abstract ID: 28975 | Poster ID: 463)

Coral reefs are among the most diverse and productive ecosystems, sustaining important services (e.g., fishery, pearl farming, tourism). With ever growing population on the coasts, the anthropogenic impacts on these reefs have increased dramatically in the last 30 years. In French Polynesia, the reef lagoon of Faaroa (Raiatea island) is exposed to contamination caused by inefficient and/or inappropriate sewage treatment, erosion from agricultural activities, eutrophication and pesticide use. The aim of this study is twofold: (i) to characterize the main domestic and agricultural pressures exerted on the reef lagoon of Faaroa through personal interview surveys and GIS analyses ; (ii) to assess the water quality of the lagoon through biological and chemical analyses of the water column and sediment, and the study of phytoplankton which plays a critical role in Polynesian lagoon ecosystems (e.g., base of food webs, important role in biogeochemical cycles). The results provide new knowledge on the impacts of human pressures on tropical reef lagoons, and will contribute to improve the conservation and management of these vulnerable ecosystems.

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CORAL HEALTH IN THE PAST: A PRE-HUMAN BASELINE FROM PARTIAL MORTALITY RECORDS IN THE PLEISTOCENE OF BARBADOS AND CURACAO (Abstract ID: 28180 | Poster ID: 12)

Coral skeletons archive corallite growth history and therefore partial mortality over tens to hundreds of years. As a result, ancient coral skeletons can provide a proxy for reef health by examining the frequency of partial mortality that resulted from stressors such as disease and bleaching. This study examines 3700 large (.5m-3m) Pleistocene corals in living position from Curacao and Barbados spanning six reef-building intervals (80-450 kya) in order to establish a pre-human baseline for partial mortality and coral health in Caribbean reef corals. For all species and all time intervals partial mortality is low (<5%). *Orbicella annularis* complex, and *Acropora palmata*had slightly higher average incidences overall (both 4%), than other massive species (*Pseudodiploria strigosa, Sideratrea siderea, Colpophyllia natans, Montastrea cavernosa*). Fast growing corals with complex morphology (eg.,*Acropora cervicornis*) were not included. Observed examples of partial mortality and regrowth were small and local and we observed no examples of significant re-sheeting of live coral over dead skeletons, as reported today for *A. palmata* killed by White Band Disease. Very low partial mortality of Caribbean corals throughout the Pleistocene provides a pre-human baseline that is in strong contrast to recent Caribbean reefs where disease and bleaching have led to widespread partial mortality of many or most larger corals alive today.

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METHODOLOGICAL UNDERESTIMATION OF NITROGEN FIXATION IN STYLOPHORA PISTILLATA (Abstract ID: 27768)

In tropical coral reef ecosystems nitrogen is a well-described limiting nutrient and its tight cycling implicated as a central component of Darwin's "paradox of the reef" where ambient concentrations of dissolved inorganic nitrogen are very low. On tropical coral reefs the primary source of "new" nitrogen can only be obtained by nitrogen fixation conducted by both photoautotrophic and heterotrophic prokaryotes. Nitrogen fixing prokaryotes are widespread in coral microbiomes and both historical and recent data have demonstrated that corals can fix nitrogen. Methodologically, both acetylene reduction and isotopic tracers have been used to quantify nitrogen fixation. Although it has been suggested that isotopic tracers are a superior approach because labeled products can be followed through various compartments, many recent isotopic experiments quantifying nitrogen fixation have observed significant underestimations for rates of nitrogen fixation in the open ocean. This discrepancy stems from the use of the "bubble technique" versus "constant enrichment", where the latter provides a more accurate approximation of nitrogen fixation rates. Here we present data using the "constant enrichment" technique demonstrating that the Great Barrier reef coral, Stylophora pistillata, does in fact fix nitrogen, although previous studies using the "bubble technique" suggested otherwise. We also present evidence that the isotopically labeled end products are primarily found within the endosymbiotic compartment (i.e., Symbiodinium sp.) of the holobiont as described previously. We hypothesize that the coral microbiome, and not mucous, is the source of this fixed "new" nitrogen.

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SYMBIODINIUM EXPOSED: COMPARATIVE TRANSCRIPTOMICS REVEALS GENETIC BASIS OF THERMAL TOLERANCE (Abstract ID: 30064)

Different putative species as well as conspecific populations of Symbiodinium exhibit a range of thermal tolerances that can determine the bleaching susceptibility of their coral hosts. However, the underlying gene regulation governing thermal tolerance in Symbiodinium is entirely unknown. Through physiological assays and transcriptomics, we compared the heat stress responses of a thermo-tolerant versus a thermo-sensitive population of type C1 Symbiodinium in culture. After 9 days at elevated temperature, neither population experienced physiological stress, but both displayed up-regulation of meiosis genes and down-regulation of metabolism genes. After 13 days at elevated temperature, the thermo-sensitive population suffered a loss of photosynthetic efficiency and an increase in reactive oxygen species (ROS) leakage from its cells whereas the thermo-tolerant population still showed no signs of physiological stress. Accordingly, only the thermo-tolerant population achieved transcriptional acclimation to elevated temperature by up-regulating an array of ROS scavenging, molecular chaperone, and metabolism genes. More transcripts of eukaryotic viral origin had also become up-regulated at elevated temperature in the thermo-sensitive population than in the thermo-tolerant population. The correlated physiological and transcriptional heat stress responses observed in our study tightly align with the known bleaching responses of corals harboring these same populations. Thus, we provide substantial, novel insights into the complex molecular mechanisms that underpin coral bleaching.

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DEFINING 'COMMUNITY' FOR COMMUNITY INVOLVEMENT IN MARINE RESOURCE MANAGEMENT IN HAWAI'I (Abstract ID: 27882 | Poster ID: 610)

Community involvement in marine and coral reef resource management is viewed by many as critical to achieving long term conservation success, and is a stated priority for local management agencies in the state of Hawai'i. Numerous programs now exist to promote active community stewardship, including formal co-management arrangements through the Community-based Subsistence Fishing Area legislation, partnerships with the State's marine enforcement unit through community Makai Watch programs, and numerous other formal and informal community based management programs. But working with communities to facilitate marine management is complex, and definitions of exactly who "communities" are and who should be included vary. This study explores definitions of community and community involvement in marine resource management in the state of Hawai'i. First, we present the results of a Hawai'i – wide survey which asked state residents how they defined "community" in relation to coral reef management. Second, we explore how these definitions relate to the wide range of actual

community-based marine management program taking place in the state of Hawai'i, with a focus on case examples on Hawai'i Island. Finally, we discuss the implications of these varying definitions and practices for community-based management practice in Hawai'i and beyond.

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LOOKING BACK TO LOOK FORWARD: AN EVOLUTION OF ACROPORA RESTORATION TECHNIQUES (Abstract ID: 29847 | Poster ID: 478)

During the last three decades reef-building corals have declined drastically. Restoration efforts have focused on innovative techniques for the propagation and growth of individual corals, as well as their outplanting to bolster remaining coral populations. The efficacy of these techniques varies greatly as well as their appropriateness for large-scale restoration efforts. The Coral Restoration Foundation has been engaged in developing practical techniques for regional reef restoration within the Florida Keys and the Caribbean. The focus of our efforts is to develop methods that result in outplants with a high level of success, are cost effective (in terms of surviving biomass outplanted), scalable for large production efforts, and able to be implemented by locally engaged volunteers for project sustainability. Herein we present an overview of the techniques that have been developed, including their origin, and the lessons learned along the way. Focusing on Acropora spp., details of various outplanting methodologies are presented, contrasting their appropriateness for large-scale restoration projects. Also reviewed are the corresponding nursery techniques that either support, or constrain, outplanting application.
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A NEW PERSPECTIVE: ASSESSING THE SPATIAL DISTRIBUTION OF CORAL BLEACHING WITH LOW-ALTITUDE REMOTE SENSING TECHNOLOGIES (Abstract ID: 28874)

Coral bleaching is contributing to the decline of reefs globally. Efficient reef monitoring, which provides information for effective management and conservation strategies, is vital to better understand the extent and severity of bleaching on coral reefs. Current in situ and remote sensing reef assessment techniques are time, money, and personnel-intensive. Consistent surveys of large reef areas using traditional techniques are unfeasible, unavailable, or uninformative at the colony level. We present a new technique using unmanned aerial vehicles (UAVs) that targets an intermediate spatial scale while providing sufficient information at the colony level to understand bleaching distributions of coral communities on patch reefs in Kaneohe Bay, Oahu during the 2015 bleaching event. Images were collected at four reefs during the bleaching period and were processed using StructureFromMotion techniques to produce georeferenced, spatially accurate orthomosaics of reef areas. Mosaics were analyzed using manual or automated classification schemes to identify benthic substrate and bleaching distribution. We found bleached colonies had random or clumped distributions on Kaneohe Bay patch reefs. Our work demonstrates that UAVs provide a low cost, efficient platform that can rapidly and repeatedly collect high-resolution imagery (1 cm) and map large areas of shallow reef ecosystems (5 hectares). We envision that similar low altitude aerial surveys would be incorporated as standard components of shallow-water reef studies, especially on reefs too dangerous or remote for in situ surveys.
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'MASTER-SLAVE' OSCILLATOR RELATIONSHIP IN SYMBIOTIC AIPTASIA (Abstract ID: 28565)

Since life first evolved in the sea, an ecosystem that is governed by a multitude of environmental cycles, species inhabiting coastal environments are challenged with complex temporal patterns, dominated by tidal and lunar cycles. Aiptasia provide a strong model for dissecting the roles of solar, tidal and lunar oscillations. A relevant question is how the presence or absence of the symbiotic algae affects Aiptasia endogenous clock. Recently we used symbiotic and aposymbiotic Aiptasia morphs to measure behavioral activity and transcriptomic for temporal gene expression. Very interestingly, our Fourier Transform analysis showed that symbiotic Aiptasia had a period cycle of 23.9 h while the aposymbiotic morphs had a locomotor activity of 12.2 h. Reinfection the aposymbiotic Aiptasia with algae and re-measure the behavior "rescued" the rhythm to a period cycle of 23.9 h under LD cycle. Additionally, transcriptomic analysis of material from our 4 hourly samplings, revealed a pattern similar to that given by the behavioral measurements, where the symbiotic anemones had a higher number of temporal expression genes with a 24 h cycle, while the aposymbiotic forms showed significantly more genes oscillating in a 12 h cycle. All the potential core circadian clock genes displayed a 24 h cycle in both symbiotic and aposymbiotic morphs. Here for the first time we can now distinguish both circadian and circatidal patterns in the Aiptasia, detected at both the behavioral and molecular levels.

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ECOLOGICAL SPECIALIZATION AND SPECIES DIVERSIFICATION OF SHALLOW WATER CORAL ENDOSYMBIONTS IN THE WESTERN ATLANTIC (Abstract ID: 29427)

In the Caribbean region, *Symbiodinium* belonging to Clade B are ecologically dominant in coral communities from shallow reef habitats. Several species in Clade B were recently described, yet genetic evidence indicates that many more remain uncharacterized. In this study, we investigate the diversity among members of a putative Pleistocene adaptive radiation exhibiting distinct ecological distributions. While many of these share identical rDNA sequences, rapidly evolving DNA suggest that multiple species exist. In testing this possibility, we sampled numerous taxa of reef-building coral across large geographical ranges and used microsatellite variation to test for recent sexual recombination. Strong genetic partitioning between sympatric populations indicates reproductive isolation. These species overlap in geographic range and correspond to the symbiont's host phylogeny. From these data, we describe the host-generalist *S. faviinorum* associating with Caribbean corals of the subfamily Faviinae as well as *S. meandriniums*associating with coral family Meandrinidae. We also describe *S. dendrogyrum*, a symbiont harbored exclusively by the coral *Dendrogyra cylindricus*, one of many host-specialized species. These investigations show how fine-scale phylogenetic and population genetic evidence reveals cryptic diversity, emphasizes the importance of niche diversification in the speciation of *Symbiodinium*, and serves as an example where the co-evolution with a single host species or monophyletic lineage leads to host-symbiont specificity.

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SEASONAL GROWTH AND CALCIFICATION RATES OF CORALLINE ALGAE ON THE GREAT BARRIER REEF AND THE DEVELOPMENT OF AN EFFECTIVE *IN SITU* STAINING METHOD (Abstract ID: 29039)

Coralline algae not only play crucial roles in reef ecology but have also been identified as one of the most sensitive calcifying organisms to ocean acidification, and a potential indicator for the effects of climate change. However, despite their importance little information is available on coralline growth and calcification rates on the Great Barrier Reef (GBR). The current lack of information on growth and calcification is partly due to the difficulty in obtaining field measurements. Therefore the aims of this study were to establish an effective method of gaining growth measurements in the field, and to determine seasonal growth and calcification rates of an abundant reef building crustose coralline algae species on the GBR. To achieve these aims we tested three calcium markers at different concentrations and exposure times on two abundant species of encrusting and branching corallines found on the GBR (*Porolithon onkodes* and *Lithophyllum pygmaeum*). We also deployed and collected *P. onkodes* samples for each climatic season taking vertical growth, marginal growth and buoyant weight measurements. Results from these experiments found calcein to be the most effective calcium marker in the field, and the optimal season for growth and calcification differed across the three metrics measured. Determining these baseline seasonal rates can assist in improving conservation and management practices, refining carbonate budgets, and to better understand the response of corallines to manipulative experiments concerning ocean acidification and warming.

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MARINE HOTSPOTS THROUGH TIME: WHAT CORAL FOSSILS CAN REVEAL ABOUT THE LOCATION AND ORIGINS OF THE CORAL TRIANGLE (Abstract ID: 29917)

Indo-Pacific diversity increases from the periphery to the Coral Triangle (CT), the global center of marine biodiversity. There are three main hypotheses to explain this pattern: Center of Origin, Accumulation, and Overlap. The relative importance of these hypotheses can be inferred with direct and indirect methods. Indirect approaches, such as phylogenetics, cladistic biogeography, and phylogeography increase our understanding of processes generating CT diversity, but fossil occurrences are the only direct record of the origin, duration, and demise of a taxon. Although the fossil record shows the hotspot moved from the Tethys Sea to its current location in the Early Miocene, little is known about the origin and spread of coral taxa themselves. To address this, we use fossil occurrence data for scleractinian corals to characterize the changing location of coral hotspots through the Cenozoic, the location of the first occurrence of coral taxa found in

each hotspot through time, and the extinction/origination rates of coral lineages. These analyses directly test hypotheses about the spatial origins of Indo-Pacific taxa as well as those about species longevity and turnover rates in the CT. Despite the substantial fossil data already available, there are inherent problems associated with an unavoidably patchy record, such as accurate species determination in a taxonomically unstable group. We use genera as a taxonomic unit to mitigate current coral taxonomy issues. We discuss causal factors in the formation of the CT and hope it will be of use in global conservation planning.

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GREATER DIVERSITY IN SYMBIONT TYPES WITHIN FLORIDA DENDROGYRA CYLINDRUS: PERSISTENT SHIFT IN DOMINANT SYMBIONT SUB-TYPES AND EVIDENCE OF CRYPTIC NOVEL CLADE (Abstract ID: 29745)

Most scleractinian corals form stable symbioses with dinoflagellates,*Symbiodinium* spp, typically with a single dominant symbiont type. The Caribbean Pillar coral, *Dendrogyra cylindrus*, harbors ITS2-B1/cp23S-B184 symbiont as its dominant type. Following a mass hyper-thermal event in August and September 2014 along the Florida Reef Tract, the *D. cylindrus*population was severely bleached. Using high-throughput Illumina sequencing of the 23S cpDNA gene region, symbiont populations within *D. cylindrus* were characterized monthly during four months of recovery. Two operational taxonomic units (OTU0.03) representing B1 phylotypes accounted for > 80% of the relative abundance in symbiont populations prior to thermal bleaching. Shift in dominance of one OTU B1 subtype from <10% pre-bleaching to >50% post bleaching occurred at a site, which recovered more rapidly than sites that did not shift *Symbiodinium*composition. Evidence of cryptic Clade A symbionts (*Symbiodinium necroappetens*) in low abundance prior to bleaching (<0.1%) were found to temporarily increase in relative abundance to 3.5% during early recovery, suggesting an opportunistic growth with an unknown functional role during recovery. These findings indicate greater symbiont diversity within *D. cylindrus* than previously known and the ability to shift to potentially more favorable symbiont types. Previously undetected diversity within symbiont communities of a single coral host may impart ecological benefits, providing a measure of resilience to environmental stressors linked with climate change for this coral species.
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GENETIC SLEUTHING: TRAIL OF SHIFTING MICROBIAL COMMUNITIES DURING WHITE PLAGUE OUTBREAK IN DENDROGYRA CYLINDRUS ON THE FLORIDA REEF TRACT (Abstract ID: 30032)

White plague disease has significantly affected Caribbean corals over the last two decades. This disease syndrome is characterized by rapid tissue loss leaving behind dead, white coral skeleton. While three types of white plague have been recognized based on how quickly the disease progresses, the pathogens that trigger this disease have not been identified with certainty. Following the Summer 2014 hyperthermal event along the Florida Reef Tract (FRT), we monitored an outbreak of white plage II (WPII) from the early onset of the disease affecting the Pillar coral *Dendrogyra cylindrus*. In order to identify potential disease-causing agents, changes of the microbial communities were tracked during five-month progression of the outbreak in in this coral species on a reef site in the FRT using 454 high-throughput sequencing of the 16S rRNA gene. Multivariate analyses comparing the microbial communities of the same coral colonies before and after showing signs of disease, compared with coral colonies that remained healthy throughout the entire outbreak, showed both an influence of sampling time and a clear effect of disease condition. Strong correlations were found between the appearance of white plague disease and highly abundant bacterial species from the genus *Sphingobium*, *Sphingomonas* and*Pseudoalteromonas*. Follow up studies using isolates cultured from active white plague colonies in trial infections will allow confirming the actual pathogen or group of pathogens causing the disease from among these identified bacterial candidates.
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THE VIRGIN ISLANDS REEF RESILIENCE PLAN: A MULTI-FACETED APPROACH TO CORAL REEF CONSERVATION IN THE US VIRGIN ISLANDS. (Abstract ID: 29673)

Over the past decade, The Nature Conservancy has lead two efforts to directly improve the quality of coral reefs throughout the Caribbean. Coral reef resilience and restoration programs have been focused on the removal/reduction of stressors, improved management of coral reef resources, and the propagation and direct restoration of coral reefs. In the US Virgin Islands, the concepts of these two programs were combined, resulting in the Virgin Islands Reef Resilience Plan (VIRRP). Developed through the TNC/NOAA cooperative agreement, the VIRRP was designed with programs and initiatives to better understand and manage for bleaching and other coral reef disturbances, reduce fishing pressure on important reef fish species, and enhance reef sites through coral restoration activities. Moreover, the BleachWatch Virgin Islands Program, the Reef Responsible Sustainable Seafood Initiative, and the USVI Coral Restoration Program all have significant community components. This active engagement through outreach and volunteer opportunities has helped to better connect Virgin Islanders to coral reefs and has created support for our coral reef conservation efforts. By working to understand and manage coral reef impacts while actively restoring key coral reef sites, we anticipate that the VIRRP will help to build the resilience of coral reefs in the US Virgin Islands.

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COMPARATIVE EXPERIMENTS ON 8 NEARSHORE HAWAIIAN CORAL REEFS: SPATIAL VARIATION IN THE ENVIRONMENTAL DRIVERS OF REEF DEVELOPMENT (Abstract ID: 30044)

Several biological and physical factors influence the development of benthic coral reef communities; however, the importance of different factors remains an important question for understanding the dynamics of a given system. We used standard PVC tiles (CAUs) to explore spatial variation in community development (36-mo.) on 8 shallow (2-3 m) coral reefs spanning 60 km of coastline in Maui, HI. Half of the 20 tiles/site were caged to examine the influence of consumers and each of the 8 sites were characterized according to 3 known drivers of nearshore reef dynamics: sediment exposure, herbivore abundance, and nutrient availability. Spatial variation in algal biomass accumulation, coral recruitment, and net accretion of calcium carbonate were compared (a) among sites, (b) among caged vs. open tiles, and (c) in relation to environmental conditions. Macroalgal biomass varied greatly among sites and a site x treatment interaction indicated variable consumer affects among sites. Recruitment varied among sites and appeared to be inversely related to sediment exposure. Open tiles always accreted greater calcium carbonate than caged tiles, indicative of a positive relationship with consumer exposure. Benthic dynamics on these coral reefs appear to be driven by different ecological processes, suggesting that managers may need to examine the specific drivers of local-regional dynamics in order to maximize the effectiveness of specific conservation efforts.

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UNCOVERING THE UNSEEN: IMAGING AND COLLECTION TECHNIQUES REVEAL DENSE COMMUNITIES OF CRYPTIC INVERTEBRATES ON HAWAIIAN CORAL REEFS (Abstract ID: 30067)

Inconspicuous motile invertebrates (cryptofauna) are ubiquitous, important components of benthic marine ecosystems worldwide; however, relatively little is known about their ecology on coral reefs. We used two methods, time-lapse imaging and artificial structures, to quantify patterns in density and community composition of cryptofauna (2-25 mm) on shallow fringing reefs in Maui, HI. Caged and uncaged artificial units (CAUs) were deployed at eight sites across 60 km of Maui's leeward coast to examine spatial variability in cryptofauna community structure and the influence of consumers, and a novel time-lapse imaging technique was used to compare communities on four dominant habitat types on natural reef substrata. CAUs demonstrated strong effects of site and caging on cryptofauna, and the effect of consumers was highly site-specific and correlated with variation in macroalgal biomass. Time-lapse imaging revealed significant variation in cryptofauna communities among coral-, algae-, and sediment-dominated habitats. Maximum densities (approximately 2000/m2) and community structure were generally similar between the two methods; however, the methods differed greatly in their strengths and utility, with time-lapse photography proving to be a promising technique for rapid assessments of cryptofauna communities. Given their high density and diversity, it is critical that we continue to develop effective methods for assessing community structure and function of cryptofauna in coral reef ecosystems.

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DETERMINING THE MOST DETRIMENTAL SEDIMENT ON CORAL REEFS: TRACING THE SEDIMENT ON THE REEF BACK TO A CATCHMENT SOURCE (Abstract ID: 29308)

We present a conceptual framework that determines the fate and impacts of sediment on marine ecosystems using the Burdekin River, Australia as a case study. We identify the most detrimental sediment to marine ecosystems and trace it back into the catchment to highlight the dominant sub-catchments, erosion processes and management practices that are delivering the excess sediment. We show evidence that Burdekin River discharge, and a portion of the associated particulate constituents, influences photic depth and turbidity on the Great Barrier Reef. Supressed photic depth over a period of time caused negative effects on coral reefs and seagrass meadows in the region. The sediment delivered from the Burdekin River that influences turbidity regimes is fine-grained (<16 µm) and is transported as organic-rich floc aggregates in flood plumes. The Bowen and Upper Burdekin sub-catchments contribute the highest loads of the <16 µm sediment fraction to the end-of-catchment and tracing data suggest that erosion rates in these catchments have increased by 7.5 and 3.6 fold, respectively since European settlement. The major erosion sources in these catchments are sub-surface erosion of scalds, rills, gullies and streambanks. Maintaining long term ground and riparian cover above 70% (in particular on soils identified as erodible) is considered important for maintaining the hydrological function of these landscapes and reducing sediment erosion and delivery from all erosion sources. Controlling livestock access to rilled and gullied areas and streambanks is a priority action to achieve this

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CAN CORALS REVEAL LAND-USE CHANGE?: TRACE ELEMENT AND ISOTOPIC RECORDS SUGGEST PATTERNS OF LAND-USE CHANGE IN THE REPUBLIC OF PALAU. (Abstract ID: 30078)

This project uses trace element and isotopic analysis of coral cores to investigate land-use activities in two watershed systems in Palau: Ngeremeduu Bay and Airai Bay. Previous studies have shown increased sedimentation in these bays, which may be correlated to earth-moving projects. Characterization of land-use change impacts on Palau's important watersheds and reef systems is needed to inform management decisions. Coral cores (20-41cm in length) were sampled along a high-to-low sedimentation gradient: near major rivers (high-impact) and ocean (low-impact). The samples were measured for isotopic indicators of environmental conditions: salinity and temperature (δ18O) and light (δ13C). The δ18O and δ13C values (‰ VPDB) ranged from -5.0 to -6.0 (δ18O) & -2.5 to -6.0 (δ13C) in high-impact sites and -5.5 to -6.5 & -2.5 to -3.5 in low-impact sites. The results indicate an isotopic transition along the high-to-low sedimentation gradient suggesting increased freshwater in Ngeremeduu Bay. The periods of lowest carbon fixation (correlated with low δ13C values) occur in high-impact sites, suggesting light-depleted conditions. Airai Bay shows a recent shift to more positive values (-4.5 to -5.5 & -1.75 to -2.25) after a period of sharp change in the isotopic signals. These spatial and temporal variations may correlate with land-use change patterns. Trace element data, including Barium to Calcium ratio, also will be presented to elucidate sedimentation dynamics and impacts of large-scale earth moving events on reef systems.
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MONITORING AND SPATIAL-TEMPORAL ANALYSIS OF CORAL REEF BASED ON MULTI-DATA (Abstract ID: 29372)

Xisha Islands, the largest archipelago in the islands of South China Sea, has abundant natural resources. The coral reefs on the Islands are typical oceanic and are the oldest and rarest ones in China. They have immeasurable social and economic values. The future of the coral reef ecosystems on the islands is worrying under the pressures from humankind activities and global warming, although they have a wide scale of self-adaptation abilities. So it should be now on the calendar to carry out the monitoring of Coral Reef,especially coral reef bleaching . In this paper, by using methods of object-oriented classification and Normalized Spectral Mixing Analysis Model, based on multi-source Remote sensing data, such as Landsat, SPOT, Quikbird, IKNOS, we obtain spatial distribution map of coral reef and coral reef bleaching. To be more scientific and convincible for research, we carry out accuracy validation by using field investigation data, analysis spatial dynamic changes and explore reasons lead to those patterns. The results are not only enable to understand real-time monitoring with multi-source images, but also are significant in monitoring of coral reef and coral reef bleaching by using remote sensing technology, in development and protection of the coral reef resources of Xisha Islands.

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POTENTIAL MECHANISMS OF INTENSIVE AQUACULTURE EFFLUENTS ON A CORAL REEF IN THE SOUTH CHINA SEA: IN SITU STUDIES (Abstract ID: 27827)

Little is known of the potential impacts and mechanisms of intensive fish farming on coral reefs. This study investigated the relations of live corals with Ulva blooms and environmental parameters along a natural gradient from aquaculture ponds in Sanya Bay. Daily dissolved oxygen fluctuated dramatically from 1.96 mg l-1 in the morning to 15.26 mg l-1 in the afternoon. Redundancy analysis showed that Ulva coverage, DO, temperature and turbidity can significantly and negatively explain the coral's distribution in 2013 and 2014. Higher partial coral mortality were recorded close to the outlet. Significantly lower rETRmax were detected on Favia sp. which was covered by Ulva spp. These resluts suggested that Ulva overgrowth, light shedding and physical abrasion may have caused the coral's physiological stress. High level of dissolved organic carbon was likely linked to severe hypoxia in the morning, which was probably one of chief mechanisms for the coral tissue mortality.

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THE EPIGENETIC REGULATION OF THE CNIDARIAN-DINOFLAGELLATE SYMBIOSIS (Abstract ID: 28776)

The symbiotic relationship between cnidarians and dinoflagellates is a keystone of the coral reef ecosystem. Despite the ecological importance of this relationship, comparatively little is known about the genes and pathways involved in the initiation and maintenance of this symbiosis. The sea anemone Aiptasia is an emerging model to study the molecular basis of the cnidarian-dinoflagellate symbiosis, because it also harbors intracellular Symbiodinium like corals, but can be reared with and without symbionts. In this study, we determined changes in DNA methylation using whole genome bisulfite sequencing of symbiotic and aposymbiotic Aiptasia in order to gain insight into epigenetic mechanisms that regulate the cnidarian-dinoflagellate symbiosis. We identified more than 1,300 differentially methylated genes between different symbiotic states. Functional analysis of these genes highlighted several significantly enriched biological processes including immunity, apoptosis, phagocytosis recognition, and phagosome formation. Interestingly, these processes involve previously identified candidate genes from expression and protein screens as well as new genes with potentially important functions in symbiont recognition, apoptotic cell clearance, and nutrient and metabolite exchange. Our data indicate that aspects of cnidarian-dinoflagellate symbioses are under epigenetic control. Further experiments elucidating the correlation of DNA methylation data with mRNA expression data are expected to provide additional insight into the biological role of DNA methylation in cnidarians.

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TISSUE LIGHT GRADIENTS SHAPE PHOTOSYNTHETIC ACCLIMATION IN CORAL SYMBIONTS (Abstract ID: 28307)

Coral reefs form some of the most diverse and productive ecosystems on Earth. They are limited to habitats with appropriate light conditions, but inhabit a wide span of light-exposed habitats from shallow reef flats to shaded caves because they are able to optimize the internal light environment for their endosymbionts. The regulation of internal light-field serves to either filter out excess light harmful to the algae, or to increase the photon flux reaching the algae in sun-exposed or shaded environments. There are several ways by which the coral host optimizes the light environment for its endosymbionts, e.g. by screening out harmful UV-radiation by chromoproteins or other fluorescent host pigments, host pigment conversion of short-wave radiation to longer wavelengths, which are more efficient for photosynthetic conversion, or increasing the internal photon flux

density in the tissue by scattering and skeleton reflection. We studied the photophysiology of the oral and aboral layers of symbiotic algae of the coral Montastrea curta to investigate if different acclimation to light exist in hospite on polyp scale. We show that the light perceived in the two layers differed >2-fold, and that this change in light facilitates different quantum yield and photosynthetic electron transport in the oral vs. aboral symbiont layer. This has important implications for the understanding of coral symbiont resilience towards high light stress, and demonstrates that the coral holobiont may exhibit canopy-like properties in respect to spatial microgradients of light and chemical parameters.

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## INITIAL FINDINGS OF THE 2014-2015 NATIONWIDE ASSESSMENT OF PHILIPPINE CORAL REEFS: NEW BENCHMARKS (Abstract ID: 28458 | Poster ID: 429)

A nationwide coral reef assessment was initiated in the Philippines in 2014 for a period of three years to update the status of reef benthos in the country. Randomly selected fringing reefs were sampled, stratified by the total area of reefs in each of six biogeographic zones. A phototransect method involving five randomly deployed 50-m transects was used to assess the cover of benthic categories in each station. Initial data up to 2015 covered a total of 80 stations (65 in Luzon, 5 in Visayas, and 10 in Mindanao), sampled across 14 provinces. The calculated average hard coral cover (HCC) was 24.7% (95% CI: 21.8, 27.7). This is comparable with HCC found by others in the Indo-Pacific region. Also, results revealed high coral diversity (average number of taxonomic amalgamation units = 31) despite low HCC in several stations. Using empirically-based benchmarks for categorizing reef condition using HCC (0-22% for poor, >22-33% for fair, >33-44% for good, and >44% for excellent), most (46%) surveyed stations were generally found to be in poor condition. These initial findings provide a firm basis for the revision of policies concerning the conservation and management of Philippine coral reefs.

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## A BENCHMARK FOR COVER AND GENERIC DIVERSITY IN PHILIPPINE REEFS (Abstract ID: 28328 | Poster ID: 425)

Benchmarks for metrics such as hard coral cover and diversity are needed for better inferences on reef status, and how these reefs are responding to environmental changes, disturbances, and management interventions. We provide benchmarks based on coral cover and generic diversity in the Tubbataha Reefs, the largest no-take marine protected area and best managed reef in the Philippines. The reef slopes of Tubbataha are monitored annually in a hierarchical manner with random transects embedded in fixed stations, stations embedded in sites, and sites within this one location. Coral cover (mean= 34%, sd=1.7) and number of coral genera in the reef slopes of the Tubbataha reefs have changed little at the location and site level from 2012 to 2015. However, these parameters greatly vary spatially. Most (71%) of the variation in coral cover is at the among site level, 9% at the among station level, and 20% at the among transect level. In contrast, total variability in number of coral genera is mostly due to among transect variation, some among station variation, and hardly any among site variation. These averages and patterns in variability over various spatial scales provide us good bases to guide interpretation of results of assessments and monitoring done elsewhere in the Philippines and the Coral Triangle.

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## TEMPERATURE AND FOOD AVAILABILITY AFFECT ASSESSMENT OF PREDATION RISK BY JUVENILE CORAL REEF FISH (Abstract ID: 28566)

Risk assessment in ectotherms is strongly affected by an organism's energy expenditure and acquisition because these will alter the motivation to feed, which is balanced against antipredator behaviours. Temperature and food availability are known to affect the physiological condition of ectotherms, but how interactions between these variables may influence predator–prey dynamics is still poorly understood. This study examined the interactive effects of food availability and temperature on the trade-offs between predator avoidance behaviour and foraging in juveniles of a marine damselfish, Pomacentrus chrysurus. Predator avoidance behaviour was tested by exposing fish to chemical alarm cues obtained from skin extract of conspecifics. When detected, these cues elicit an antipredator response in fish, typically characterized by decreased foraging. Fish maintained under high food ration displayed distinct antipredator responses to chemical alarm cues, regardless of temperature. However, fish maintained in conditions of low food ration and 3 °C above ambient temperature did not display an antipredator response when exposed to chemical alarm cues, whereas those in ambient temperature did. These results suggest that individuals in low physiological condition because of limited food availability are more susceptible to increased temperature and may therefore take greater risks under predation threats to satisfy their energetic requirements. Projected business-as-usual climate change scenario adds urgency for more research on this topics.

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## EPIGENETIC CHANGES IN THE CORAL *STYLOPHORA PISTILLATA* IN RESPONSE TO LONG-TERM OCEAN ACIDIFICATION (Abstract ID: 28563)

Coral reefs are in rapid decline, chiefly from anthropogenic factors. As corals have a long generation time, epigenetic adaptations e.g. DNA methylation and histone modifications likely play a large part in coping with long-term stresses, in tandem with natural selection. There is indirect indication that methylation regulate transcriptional noise in the coral *Acropora millepora*based on the assumption that methylated genes had lower amounts of CpG dinucleotides. However, large-scale, direct evidence describing the methylation states of coral genes from whole genome bisulphite sequencing (WGBS) has, so far, been lacking. In our work, we chose the Red Sea coral*Stylophora pistillata* to study changes in the methylation landscape in response to ocean acidification. We obtained WGBS data on coral nubbins grown *in aquaria* for two years in controlled conditions with only the $pCO_2$altered to simulate projected acidities of the world's oceans. We have identified a

number of genes that undergo differential methylation in more acidic conditions, and some of the genes are thought to regulate calcification and bone mineralisation. This is in agreement with the phenotypic changes observed in the corals grown under more acidic conditions, as growth rates of the corals remain constant while the skeleton structure was more porous and less dense. Correlations drawn between gene expression and their corresponding methylation patterns provide further support for observed phenotypic adaptations in response to prolonged ocean acidification.

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TOWARDS NETWORKING OF NATIONAL PROTECTED AREAS FOR THE CONSERVATION OF CRITICAL HABITATS OF GREEN SEA TURTLE POPULATIONS IN THE PHILIPPINES (Abstract ID: 29264 | Poster ID: 646)

The establishment of local MPAs and networks for the conservation of coastal ecosystems and fishery management is widely practiced in the Philippines. Some networks are established on the basis of ecological connectivity among MPAs, while others are networks for learning and complementation of coastal resources management activities. Under the cooperation of Indonesia, Malaysia and the Philippines in the SSME, over 10 protected areas across the 3 countries, known to support different life stages of green sea turtles from the same population, are envisioned to form a transboundary network. The Biodiversity Management Bureau and its partners are in the process of establishing the Philippine part of the transboundary MPA network. The process involves developing institutional systems for the operationalization of the network, including improving management effectiveness in each site and strengthening enforcement through better communication and coordination. It also engages other sectors and institutions for advancing sea turtle research and building capacities to address the conservation needs for effective management of sea turtle habitats and to promote sustainable fisheries management in the selected sites. This is a new initiative for the country since this is the 1st networking of national protected areas based on linked habitats critical of a particular population of the endangered green turtle, *Chelonia mydas*. The initiative contributes to the Philippine international commitments that include the CMS,CBD and CTI-CFF.

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ECOPHYSIOLOGY OF A CORAL SPECIES IN THE NORTHERNMOST ATLANTIC REEF SYSTEM: EFFECTS OF LOW TEMPERATURES ON SIDERASTREA RADIANS IN BERMUDA (Abstract ID: 28731 | Poster ID: 320)

Thermal stress induced by low seawater temperatures is a primary factor restricting coral growth and distribution. High latitude reefs may support coral populations that are resilient to thermal stress since they are exposed to wide annual temperature ranges. In Bermuda, the northernmost Atlantic reef system, corals are subjected to average temperatures below 18°C in the winter. The physiological responses of the zooxanthellate coral species*Siderastrea radians* to low temperatures were assessed by two experiments. Firstly, replicate colonies were subjected to reductions in temperature of 2°C every two days from ambient (25°C) to an extreme low of 15°C and back to ambient. Gross productivity was significantly depressed only at 17 and 15°C with rates recovering to initial values once temperatures returned to ambient. The photochemical efficiency of the colonies fluctuated over time and reached the lowest levels at 21°C and 15°C. Secondly, replicate colony nubbins were maintained in consistent temperature treatments of 25°C, 21°C and 17°C for two weeks. The exposure to 17°C caused significant decreases in photochemical efficiency and in the chlorophyll a concentration with no signs of recovery over the experiment; however, net calcification rates did not vary among treatments. Overall, even though low temperatures disrupted photosynthetic activities of the algal symbiont within *S. radians*there was recovery over the short term exposure to the extreme low temperatures. This research gives insight into thermal resilience of tropical corals at high latitudes.

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SPAWNING PATTERNS DIFFER BETWEEN ACROPORA AND MERULINID CORALS (Abstract ID: 28302)

Spawning patterns of scleractinian corals were examined in situ at Lyudao, southeastern Taiwan in 2010–2015. Spawnings of a total of 47 species were recorded. In the genus Acropora (including 13 species), annual spawning occurred on a single night, 3–11 days after the full moon mostly in May. In contrast, in the massive coral family Merulinidae (including 16 species from six genera, Dipsastraea, Favites, Hydnophora, Leptoria, Goniastrea and Platygyra), annual spawning occurred continuously over 2–3 nights and always around the last quarter moon in April and May. Moreover, spawning of Acropora corals usually occurred on an earlier lunar day at southern coast than at northern coast, but merulinid corals spawned in the same timing of lunar days (around the last quarter moon) between the coasts. The different spawning timing of Acropora corals between the coasts may be caused by different local environmental conditions between the coasts (e.g., seawater temperatures and weather). The results of this study demonstrated the different spawning patterns of Acropora and merulinid corals and suggested different regulatory mechanisms determining their spawning timing.

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DO DIFFERENT SEAGRASS SPECIES SUPPORT UNIQUE BENTHIC MACROFAUNAL COMMUNITIES? (Abstract ID: 28536)

Structural complexity is often considered to be responsible for the high biodiversity associated with seagrass beds. This study aimed to examine the effects of different seagrass species on the abundance and community structure of benthic macrofauna. Sediment cores were taken from monoculture beds of five seagrass species in Dongsha Island, a remote atoll in the South China Sea, including Cymodocea serrulata (CS), Cymodocea rotundata (CR), Halodule uninervis (HU), Syringodium isoetifolium (SI), and Thalassia hemprichii (TH) across four seasons. HU and SI demonstrated higher shoot density, but TH, CR, and CS were present at higher seagrass biomasses per unit area. Sediment grain size was significantly larger in the CS beds. The sediments of the TH beds displayed the higher sorting coefficient, as well as the highest silt/clay and organic content. Furthermore, the TH beds were characterized by the highest macrofauna abundance (12,304 individual m-2) and richness (17 taxa). The macrofaunal communities were significantly different between the beds of the five different seagrass species. The TH beds were dominant solely by malacostracans, but polychaetes and malacostracans were co-dominant in the beds of other species. While polychaete abundance was higher in the CR beds, ophiuroids, malacostracans, and ostracods were more abundant in the TH beds. Positive correlations were detected between amphipod abundance and sediment organic content and between gastropod abundance and seagrass biomass, indicating that the macrofaunal communities were primarily influenced by food resources, but not physical structure.

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A PHYLOGENOMIC APPROACH REVEALS THE MONOPHYLY OF SCLERACTINIANS (Abstract ID: 28970)

Calcification is one of the most distinct traits of scleractinian corals. Their hard skeletons constitute the substratum of the iconic reef ecosystems and confers corals their remarkable diversity of shapes. The evolutionary relationship between scleractinians and the closely related non-calcifying coralimorpharians is key to understand how calcification emerged and evolved in corals. The crucial question is whether scleractinians form a monophyletic group or, alternatively, if coralimorpharians are nested within corals and have lost their ability to calcify (the so-called "naked-coral" hypothesis). However, despite major efforts based on comparison of morphological traits and molecular markers, the relationship between scleractinians and corallimorpharians has remained unresolved and controversial. Extensive phylogenetic analyses based on a large number of full mitochondrial genomes were not able to unambiguously resolve their evolutionary relationship. This difficulty is partly attributable to the considerable heterogeneity in composition and evolutionary rates of the mitochondrial sequences in the different scleractinian and corallimorpharian clades. Here a new analysis is presented based on 291 single copy nuclear protein-coding genes from 15 anthozoan taxa. Unlike the mitochondrial sequences that suggested the "naked coral" hypothesis, these nuclear markers do not display any distinct compositional bias in their nucleotide or amino-acid sequences. Several phylogenomic approaches congruently reveal a topology consistent with scleractinian monophyly and corallimorpharians as the sister clade of scleractinians.

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ANALYSES OF CORALLIMORPHARIAN TRANSCRIPTOMES PROVIDES NEW PERSPECTIVES ON THE EVOLUTION OF CALCIFICATION IN THE SCLERACTINIA (CORALS) (Abstract ID: 28129)

Corallimorpharians have a close phylogenetic relationship with corals and can potentially provide novel perspectives on the evolution of biomineralization within the Hexacorallia. Surveying transcriptomes of corallimorphs led to the identification of orthologs of some skeletal organic matrix proteins that were previously considered to be restricted to corals; this is significant given that surprisingly few of the proteins identified in the skeletal proteome are coral-specific. Whilst carbonic anhydrases are ubiquitous proteins involved in CO2 trafficking, both calcification and photo-symbiosis are assumed to place increased demands on the CA repertoire. These have presumably driven the elaboration of complex CA repertoires that are typical of corals. Comparison of corallimorph CAs with those of corals indicates that corals have specifically expanded the secreted and membrane-associated type CAs, whereas similar complexity is observed in the two groups with respect to other CA types. Similar numbers and type distribution of CAs between the symbiotic and non-symbiotic corallimorphs suggests that, whereas an expansion of the CA repertoire has been necessary to enable calcification, it may not be a requirement to enable symbiosis. Consistent with this idea, preliminary analysis suggests that the CA complexity of symbiotic and non-symbiotic sea anemones is similar. This study is consistent with the idea that coral calcification evolution required relatively few new genes, that are largely involved in the deposition process, but also the expansion of a specific type of CA.

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SYMBIODINIUM KAWAGUTII GENOME ILLUMINATES DINOFLAGELLATE GENE EXPRESSION AND CORAL SYMBIOSIS (Abstract ID: 29385)

The lack of a good understanding on establishment and regulation of coral-Symbiodinium symbiosis at the genomic level has hampered efforts to understand and manage coral bleaching and degradation. By high-throughput sequencing we (an international team) analyzed the 1180-Mb genome and RNA of Symbiodinium kawagutii. The genome has been subjected to active (retro)transposition and gene family expansion, especially in processes important for successful symbiosis with corals. We found an altered glycan pathway that specifies (GlcNAc)5(Man)5(Asn)1 glycan rich in free mannose branches and terminal mannose-mannose units available for lectin binding in host recognition. Numerous genes related to legume-root nodule symbiosis and parasite virulence identified may be related to the initiation of the symbiosis. A high number of transporters were catalogued potentially facilitating material exchanges between the Symbiodinium and a symbiotic coral like Acroporal digitifera. We also documented genes potentially governing sexual reproduction and cyst formation, indicating that the symbiotic lineage maintains a typical dinoflagellate life cycle. Most strikingly, we identified an extensive microRNA system that appears to regulate genes expression not only in Symbiodinium but also in a host coral. Further comparative genomics analyses suggest that the type of photosynthate supplied by the symbiotic alga and nutrients by the coral host can vary among symbiosis systems, implying that biochemical complementarity may be key to host-symbiont selection and robustness of the symbiosis system in face of environmental stress.

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MULTIPLE STRESSORS ON TEMPERATE CORALS: INSIGHTS FROM EXPERIMENTAL, OBSERVATIONAL AND MODELLING STUDIES (Abstract ID: 29773)

Local and global disturbances are increasingly affecting marine biota and are of major concern for the management of marine ecosystems worldwide. Understanding how these stressors interact and the resulting cumulative impacts is critical to improve our predictions of the evolution of marine ecosystems in changing oceans. While multiple stressors' interactions in corals have been mostly assessed in laboratory, the combination of different approaches such as laboratory, observational and modelling studies is essential to better understand and predict the response of these organisms. Our research focuses on the effects of global and local stressors and their interaction on different temperate corals: the coral Cladocora caespitosa and the octocorals Paramuricea clavata and Corallium rubrum. We will show different results from: (1) laboratory experiments studying the interaction between global stressors such as warming and invasive species, (2) field studies of warming and acidification effects and their potential interaction from observations at CO2 vents and other non-acidified sites, and (3) modelling the effects of multiple stressors and the interaction between warming and local stressors such as fishing or recreational diving. The results point out the importance of bearing in mind the synergistic effects of stressors acting at multiple scales when designing and implementing conservation actions at local scale. Finally, we demonstrate how combining all these approaches can help to better foresee the potential effects of global change in reef organisms.
http://www.medrecover.org

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PALAU'S NORTHERN REEFS: SCIENCE AND MONITORING USED TO GUIDE THE MANAGEMENT AND ASSESS THE RECOVERY OF CORAL REEF FISH STOCKS (Abstract ID: 29390)

As fishing pressure has lead to declines in coral reef fish stocks, it has become evident that new management approaches are needed to ensure the sustainability of these fisheries. We present a case study from the northern reefs of Palau, where two states have decided to co-manage their fishery resources to safeguard their livelihoods, food security and fishing culture. Previous analysis of the main fishery targeted species showed that spawning potential ratios (SPRs) were below the threshold that allows stocks to recover. Here we describe the science and recommendations used to put the stocks back on a path of recovery, and present the monitoring protocols used to assess the effectiveness of these strategies. For baseline monitoring we used fishery-dependent and -independent data collection techniques, including dive and fish landing surveys, where we applied stereo-video technology to accurately and efficiently survey exploited fish stocks. We report on size frequencies and biomass from dive surveys covering 65 km of transects across different depths, habitats and protected area status. Our baseline data reveal that stocks in frequently fished areas exhibit truncated size frequency distributions and reduced biomass compared to stocks in effectively enforced MPAs. We also compare the diving survey data to the local estimates of size at maturity, size frequencies and species composition extracted from catch data collected by local fishers. This case study documents an achievable approach to coral reef fisheries assessment and monitoring that can be applied to other regions.

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FOLLOWING PROTEOMIC CHANGES IN SYMBIOTIC *AIPTASIA* CYTOSOL AND SYMBIOSOME MEMBRANES DURING THERMAL STRESS (Abstract ID: 29550)

We are investigating the pathways involved in thermal-induced bleaching in cnidarian-dinoflagellate symbiosis by analyzing in parallel changes in mRNA and protein abundance. Symbiotic *Aiptasia* anemones hosting the clonal *Symbiodinium* strain SSB01 were subjected to thermal stress at 34C and sampled at 0, 24, and 48 h to reflect pre-stress, onset of bleaching, and approx. 50% bleaching, respectively. Anemone homogenates were separated into host and algal fractions. Host fractions were further separated into cytosolic (CF) and membrane-enriched fractions (MF). CF and MF were labeled with isobaric tags and subjected to LC-MS/MS mass spectrometry. Data analysis is in progress. In addition, to allow a more detailed analysis of a particularly interesting protein set, we are preparing a symbiosome-membrane sample using antibodies to guide fractionation. We confirmed that the PC3 monoclonal antibody (Wakefield and Kempf, 2001; a generous gift from S. Kempf) stained material surrounding algae in symbiotic tissues and in host homogenates but not in axenic algal cultures. We also generated a peptide-directed antibody against the glucose transporter Glut8, validated its specificity by Western blots and peptide competition, and showed staining of the symbiosome membrane by immunofluorescence. By sucrose-density-gradient centrifugation, we isolated a fraction that stained strongly with both PC3 and anti-Glut8 antibodies. Further characterization of this fraction (to identify possible contaminating membrane elements) is underway as a prelude to its analysis by LC-MS/MS.

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ADVANCING ECOSYSTEM-BASED MANAGEMENT: ECOSYSTEM-BASED FISHERIES MANAGEMENT POLICY AND ROADMAP, WITH PARTICULAR EMPHASIS FOR CORAL REEFS (Abstract ID: 28073)

NOAA has adopted ecosystem-based management (EBM) as the approach for meeting the agency's mandates to sustainably manage the nation's marine resources. Ecosystem-based management is an integrated approach that incorporates the entire ecosystem, including humans, into resource management decisions across all ocean-use sectors. EBM accounts for a changing marine climate and is guided by an adaptive management

approach. EBM is informed by science to ensure resilience in marine ecosystems and in the goods and services they provide. NOAA Fisheries is advancing EBM for the fisheries sector through development of an Ecosystem-Based Fisheries Management (EBFM) Policy Statement and associated Roadmap. This presentation will provide an overview and update of the draft EBFM Policy Statement and Roadmap, how they relate to other efforts, and discuss how we'll know when we're doing EBFM. This work will particularly emphasize the unique and important facets about coral reefs that make them especially amenable and requiring of EBFM.

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DIEL PATTERNS OF CELLULAR OXYGEN CONCENTRATIONS AND AEROBIC AND ANAEROBIC ENERGY PRODUCTION IN CORALS (Abstract ID: 28899 | Poster ID: 21)

Corals experience hyperoxia during the day due to Symbiodinium photosynthesis and hypoxia at night due to respiration by the coral holobiont. Previous studies have revealed corals undergo daily oscillations in the expression of putative metabolic genes. However, the anaerobic energy production pathways in corals are unknown. To study the link between nighttime hypoxia in coral tissues and cellular energy production, the branching scleractinian species Acropora yongei was studied in a laboratory setting. Oxygen concentrations were measured in the diffusive boundary layer using microelectrodes, demonstrating daily hyperoxia and nightly hypoxia. Branches were sampled every 4 hours over a diurnal cycle to measure metabolic enzyme activity, metabolites, and protein expression by 2D gels. For the first time, it was shown that corals produce strombine, an end metabolite of anaerobic glycolysis. High amounts of strombine were present in coral tissues during the day as well as at night. Enzyme activity assays revealed that aerobic energy producing pathways were significantly less active during the night versus the day. Thus, the relative contribution of anaerobic glycolysis was greater at nighttime, corroborating the concept of nightly functional anaerobiosis in corals. However, protein expression of detectable glycolytic and TCA cycle enzymes did not exhibit diel patterns. Therefore, the transition from aerobic metabolism during the day to anaerobic metabolism at night appears to be controlled on the substrate level and by posttranslational modifications to metabolic enzymes.

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PHAGE-BACTERIA INTERACTIONS IN CORAL REEF BENTHIC COMPETITION (Abstract ID: 28919)

Bacterial communities mediate coral reef ecosystem transitions from coral- to algal-dominated communities through shifts in metabolisms at the interaction zones. Anthropogenic disturbances such as overfishing and nutrient loading stimulate algal growth, aiding turf and macroalgae to outcompete stony, reef building corals. Here we present data using bacterial and viral metagenomes from benthic competitive interaction zones in the Southern Line Islands, a pristine reef system that offers a unique model to assess baselines. We sequenced 200 samples from 15 different types of interactions including corals of the genera Porites, Acropora, and Montipora, and algal functional groups such as Halimeda, filamentous red algae, turf algae, and crustose coralline algae. Our approach allows for a robust understanding of how viral and bacterial communities may mediate physiologic events that lead to phase shifts. This is the most comprehensive and detailed metagenomic dataset on coral reef benthic interactions available to date. We found that coral-associated bacteriophage communities exhibit a higher prevalence of mucus binding properties, indicating that corals utilize phage-mediated immunity against invasive bacterial pathogens. In addition, the algal-associated communities exhibited higher levels of lysogeny, a feature that may facilitate algal microbes to invade coral holobionts by containing more temperate phage communities and thus expressing phage-encoded genes that offer competitive advantages such as virulence factors.

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NOAA CORAL REEF WATCH'S PROBABILISTIC SEASONAL-SCALE CORAL BLEACHING THERMAL STRESS OUTLOOK SYSTEM FOR INFORMING MANAGEMENT DECISIONS (Abstract ID: 28196 | Poster ID: 534)

The National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Watch (CRW) and National Centers for Environment Prediction (NCEP) recently released version 3.0 of the global Coral Bleaching Thermal Stress Outlook system, based on sea surface temperature (SST) predictions from NCEP's operational Climate Forecast System Version 2 (CFSv2). Every week, the Outlook system predicts the probability of thermal stress capable of causing mass coral bleaching for several months in advance (current online products are ordinarily released out to four months), using 28 ensemble members derived from the CFSv2 SST forecast runs over the previous week. CRW uses a recently developed skill analysis tool to investigate regionally- and lead-time-dependent skill levels of the Outlook. The v3 Outlook system and associated skill analysis will be presented. An even newer version of CRW's Outlook is currently under development to incorporate additional, short-range SST forecasts from the CFSv2 to increase Outlook skill during the first three months of lead-time. CRW's Coral Bleaching Outlook system is critical to its global decision support system for coral bleaching management and helps managers and other stakeholders prepare for and respond to environmental stresses to coral reefs.
http://coralreefwatch.noaa.gov/satellite/bleachingoutlook_cfs/outlook_cfs.php

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EFFECTS OF OCEAN WARMING AND ACIDIFICATION ON THE SEAGRASS *THALASSIA HEMPRICHII* FROM CORAL REEFS OF KENTING, TAIWAN (Abstract ID: 28666)

Seagrass beds provide important carbon sinks in coastal ecosystems, and it is thought that increasing the quantity of natural carbon sinks could help to slow the rate of global climate change (GCC). Therefore, understanding the natural carbon sinks on seagrass beds, as well as how these high-productivity marine ecosystems are influenced by climate change factors, are critical issues. A mesocosm-based approach was taken herein in which the seagrass *Thalassia hemprichii* and reef corals of Kenting, Taiwan, as well as additional ecological functional groups, were cultured under either control or elevated temperature and/or ocean acidification (OA)-simulating conditions. After 12 weeks, OA (800 ppm) was found to increase seagrass productivity, below-ground biomass, rhizome carbon content, and carbon sequestration. Rising temperature (25 to 31°C) increased the maximum quantum yield (Fv/Fm), productivity, relative dry weight, carbon sequestration, growth rate, and decomposition rate, but reduced shoot density and the carbon content of the roots and leaves. *T. hemprichii*demonstrated highest productivity, relative rate of dry weight increase, Fv/Fm, growth rate, below-ground biomass, shoot carbon content, and carbon sequestration at the high temperature + OA treatment. The estimated carbon budgets models showed that *T. hemprichii*-dominated seagrass bed under OA and 31°C warming displayed the highest leaf production, below-ground production, and above- and below-ground carbon storage, suggesting that *T. hemprichii* could benefit from GCC by absorbing and storing more carbon in the shoots and surrounding sediments.

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FOSTERING SOLUTIONARIES AND OCEANPRENEURS IN OCEAN YOUTH'S CORAL WORKSHOP (Abstract ID: 29899)

Ocean Youth is a capacity building program for tomorrow's leaders and change-makers to conserve our oceans. The program is for 13-25 year olds and consists of remote interaction via a digital platform and face-to-face interaction with workshops and special events hosted by SEA LIFE aquariums around Australia. There are 3 phases in the online program starting with an introduction to "Ocean Care" issues (and potential solutions) including climate change, pollution and overfishing. The second phase, "Changemakers

in Action" is about getting inspired by amazing people making a positive difference for oceans by influencing change in their community and beyond. The third phase, "Solutionaries and Oceanpreneurs Unleashed", is about building the skills and confidence to create and implement solutions to protect and conserve oceans. Ocean Youth's Coral Workshop gives participants the chance to experience the fascinating world of reef-building corals. There are hands-on opportunities to learn about coral identification, discover coral fluorescence and go on a virtual dive. They are inspired through interviews with scientists talking about what can be done to reverse anthropogenic impacts on coral reefs. Future opportunities will exist for these participants to get involved in reef restoration and citizen science projects. Ocean Youth Ambassadors are currently being fostered through face-to-face interactions in Sydney, Melbourne & Mooloolaba while the online platform allows for global participation and the world is their oyster.
http://www.oceanyouth.org/

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A TEN YEAR TEMPERATURE RECORD FROM A SHALLOW WATER REEF IN THE MESOAMERICAN BARRIER REEF LAGOON (Abstract ID: 29875 | Poster ID: 362)

The Mesoamerican barrier reef system in the western Caribbean creates a large region of lagoon coral reef habitat. As the largest lagoon habitat within the Caribbean, this region experiences differing oceanographic and temperature conditions as compared to offshore areas. The occurrence of several endemic species within the area also supports this area as a unique biogeographic region. This study presents an underwater temperature record over a ten year period (2004-2014) collected from Wee Wee Caye within the South Water Caye Marine Reserve of Belize. These data will be put into context by comparison to other Caribbean data sets.

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JOHNSTON ATOLL: REEF FISH HYBRID ZONE BETWEEN HAWAII AND THE EQUATORIAL PACIFIC. (Abstract ID: 29790 | Poster ID: 32)

Johnston Atoll is isolated in the Central Pacific Ocean (16°45—N 169°31—W). The nearest landfall is French Frigate Shoals , 804 km (500 miles) north in the northwest Hawaiian Islands . It is about 1,287 km (800 miles) southwest of Honolulu, Hawaii. The Line Islands of Kiribati are about 1,440 km (900 miles) south and the Marshall Islands are about 2,560 km (1,600 miles) to the southwest. The labrid species, Thalassoma lutescens has wide range distribution from the Indo-Pacific throughout the Line Islands. The related species, Thalassoma dupperryi, is endemic to the Hawaiian Islands. The larvae of both species make it to Johnston Atoll where we have found a mix of phenotypes representing a range of hybridization events. The hybrids are easily distinguished by coloration. The large number of hybrid individuals and the diversity of their coloration suggest that the hybrid population is also locally sustaining. We also observed the arrival of two damselfish species to the atoll and their subsequent hybridization: Abudefduf adominalis and vaigiensis. This paper is based upon scientific diver observations of fish species at Johnston Atoll during the period of 1983 to 2003. The pattern and abundance of the hybrid wrasse will be described. We will also add notes on species that have been seen only on rare occasions and thus suggest infrequent long-range dispersal.

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A PASSIVE ACOUSTIC SURVEY OF FISH SOUND PRODUCTION AT RILEY'S HUMP WITHIN TORTUGAS SOUTH ECOLOGICAL RESERVE: IMPLICATIONS REGARDING SPAWNING AND HABITAT USE (Abstract ID: 27959)

Passive acoustic recorders were used to monitor sound production indicative of the use of spawning habitat by groupers (Serranidae) at Riley's Hump, which is located in the Tortugas South Ecological Reserve (TSER), part of the Florida Keys National Marine Sanctuary. Sound production by black grouper (Mycteroperca bonaci), red grouper (Epinephelus morio), and red hind (E. guttatus) was recorded year-round and at all times of day but occurred more often in the evening during the winter-spring spawning period than during other times of day and year. This pattern for these species is consistent with results of previous studies that documented the association of sound production with reproductive behavior at spawning sites. Distinct diel and seasonal patterns of sound production by the longspine squirrelfish (Holocentrus rufus) and bicolor damselfish (Stegastes partitus) also were recorded. Riley's Hump is a documented spawning site for mutton snapper (Lutjanus analis), and recordings of black grouper, red grouper, and red hind indicate that it is used for reproductive purposes by these species as well. These results demonstrate the importance of the TSER and the need for continued research to understand its effect on the recovery and sustainability of managed fish populations.
http://fishbull.noaa.gov/1141/locascio.pdf

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STRENGTHENING CITIZEN SCIENCE NETWORKS TO BENEFIT THE GREAT BARRIER REEF (Abstract ID: 29231 | Poster ID: 725)

Citizen science is gaining recognition as a means for public collection of valuable information which can improve reef management outcomes. Benefits include increased data to supplement scientific research programs; community engagement and capacity building; and cost-effective and innovative program structures. Yet, citizen science programs often face significant challenges to deliver sustainable and best-practice programs. Some of the common difficulties include insufficient funding, limited staff capacity, insufficient awareness of the program by data users, and/or perceptions of the low credibility of citizen science data. In 2012, a scoping study consulted a range of stakeholders to identify critical needs and opportunities for a more coordinated approach to citizen science across the Great Barrier Reef (GBR). The Great Barrier Reef Citizen Science Alliance (Alliance) network evolved as a response to this study. The Alliance mission is to foster collaboration, capacity building, advancement and action for citizen science that benefits the Great Barrier Reef. The program is hosted by the Great Barrier Reef Foundation, with support from corporate partner Boeing. Ten member groups from coastal and marine citizen science programs are actively engaged in this initiative. This presentation will share the past successes, strategies and future plans of the Alliance. It will showcase the benefits of a strategic and collaborative approach to strengthen opportunities for citizen science providers, researchers, Reef managers and the Australian community to tackle key Reef issues.
http://www.greatbarrierreefcitizenscience.org.au

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MAKING WAVES: REEF CITIZEN SCIENCE FOR IMPACT (Abstract ID: 29396)

Engaging volunteers in marine citizen science projects has intrinsic value in regards to community capacity building and education. Yet the process of developing strategic citizen science projects and translating data into valued results with natural resource management applications can be challenging. Since 2001, Reef Check Australia has facilitated hands-on marine citizen science research and education projects. Four case studies showcase lessons learned from programs designed to create valuable social and environmental outcomes through engagement of volunteers. 1)Identifying and responding to data gaps through volunteer reef monitoring of subtropical reefs in South East Queensland. 2)Demonstrating citizen science data quality through a precision study on volunteer data and analysis of 14 years of globally standardised Reef Check reef health data in Queensland. 3)Adapting citizen science protocols to expand project opportunities that enhance capacity building, partnerships and strategic natural resource management applications through reef habitat mapping. 4)Tailoring new pathways for sharing citizen science findings and engaging volunteers with the community via a Reef Check Ambassadors community outreach program. Through these case studies, we share our approach, lessons learned and successes. This offers insights into potential approaches

for developing targeted and flexible citizen science projects and showcasing the work of volunteers and project stakeholders, and collaborating with partners for beneficial research, management and education applications.
http://www.reefcheckaustralia.org

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MANELL-GEUS: A MODEL FOR FOSTERING MULTI-AGENCY COLLABORATION (Abstract ID: 28432)

Guam's Manell-Geus watershed contains extensive coral reefs and sea grass beds. These habitats support a strong fishing tradition and important cultural connections, but they are impaired by poor water quality associated with sedimentation and stormwater management issues. NOAA's Coral Reef Conservation Program and Guam's local coral managers identified Manell-Geus as one of two priority sites in 2010, while NOAA Fisheries named the site a Habitat Blueprint Focus Area in 2013. These two designations have catalyzed new partnerships for increased conservation work in the watershed, including in-kind as well as funding support from a range of local, state, federal and non-government organizations. With coordination and technical assistance from NOAA's Coral Program, partners are currently working on a range of forest restoration, habitat mapping, water quality, and other efforts to address threats to the watershed and its adjacent coral reefs. Private and community partners also participate by volunteering, providing access to private lands, and learning new skills to actively conserve these areas. NOAA's commitment to fostering partnerships for this site is increasing conservation efforts both in Manell-Geus and around the island.

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PROFESSIONAL SCUBA DIVERS ABOVE THE WATERLINE: USING EXPERT ASSESSMENT TO INFORM CORAL REEF MANAGEMENT (Abstract ID: 29585)

Scientists and natural resource managers have increasingly recruited SCUBA divers to collect data that will improve our understanding about the status of marine resources and environments. Increased reliance on this group has enabled researchers to expand data collection efforts, while minimizing research costs. In most cases, diver-collected data has been limited to observations recorded by divers while underwater. The present research, however, explores the possibility of employing above-water PGIS methods to collect spatial data that can be used to assess the ecological status of coral reefs. Using PGIS data provided by occupational SCUBA divers in the USVI, the authors propose that local ecological knowledge can be used to provide an expert assessment of the relative quality and threat levels of area coral reefs, as well as understand which reefs are most used. With this information, resource managers can more effectively control management investments and actions to benefit the end-users as well as the coral reef resources. By looking at the co-occurrence of reef quality characteristics and stress levels in coral reef areas used by people, resource managers can better decide whether to monitor reef quality, work to mitigate or reduce threats, initiate restoration activities, or simply divert management effort to other areas. In ideal cases, expert assessment can serve as a supplement to biophysical data collected through regular coral reef monitoring. Where rich biophysical data does not exist, expert assessment may be a substitute.

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THE HOLDFAST IS KEY: SARGASSUM REGROWTH FROM HOLDFASTS RAPID UNLESS REMOVED BY HERBIVORES (Abstract ID: 28942)

Macroalgae, especially large, canopy-forming species, are generally seen as a sign of reef degradation. Macroalgal-dominated states are difficult to reverse, as macroalgae pre-empt space on the benthos and shade and abrade coral colonies. However, it has recently been hypothesised that storms/cyclones may provide a window of opportunity for the recovery of coral populations by removing the algal biomass. We conducted an experiment demonstrating the resilience of Sargassum to cyclone impacts by creating 1.5x1.5m 'plots' in which we either cut the Sargassum at the stipe, leaving the holdfast (simulated cyclone effect), removed the holdfasts completely or removed nothing (control). The regrowth of the Sargassum with intact holdfasts was indistinguishable from control plots, demonstrating that Sargassum is capable of rapid regrowth from holdfasts after storm/cyclone damage. Further, we examined if herbivores are capable of damaging these holdfasts, preventing regrowth. Pieces of coral rubble with attached Sargassum were moved to areas of high herbivory, the number and size of holdfasts quantified, and exposed to one of three treatments for a period of 16 weeks: i) caged to exclude herbivores, ii) exposed to herbivores, iii) exposed to herbivores then caged after 8 weeks. Parrotfishes were responsible for the removal of holdfasts and limited the potential for regrowth. The window of opportunity hypothesis for the recovery of coral populations would therefore only be possible when co-occurring with increased herbivory.

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GLOBAL PROJECTIONS OF CORAL BLEACHING UNDER WARMING AND OCEAN ACIDIFICATION USING A MECHANISTIC MODELLING APPROACH (Abstract ID: 29909)

Global climate models project increased rates of mass coral bleaching such that many of the world's reefs will disappear by mid-century. Typically, models use a Degree Heating Week (DHW) – based bleaching threshold in combination with sea surface temperature (SST) output from global climate models. While these approaches are empirically justifiable, they are nonspecific in applying a generic bleaching threshold to all coral species and typically do not incorporate the potential for corals to adaptively respond to an increasingly warmer, more acidic ocean. We scaled up a mechanistic model of coral and symbiont ecological dynamics and symbiont evolutionary dynamics to the global scale, and estimate severe bleaching events based on declines in coral cover. The model was run for changes in SST and water chemistry predicted by the NOAA/GFDL Earth System Model 2 through 2100. We normalized the model to achieve a reasonable global severe bleaching frequency (~10%) between 1985-2010 based on ReefBase bleaching observations. Coral bleaching responses to rising SSTs are tested using susceptible versus tolerant coral types, with and without variation in symbiont thermal tolerance, and in combination with ocean acidification. Projected bleaching frequencies are also compared and contrasted regionally to results from previous DHW–based threshold models. A global mechanistic model provides a valuable tool for assessing the potential effects of genetic or community-level variation in symbiont thermal tolerance on projected rates of mass coral bleaching.

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INITIAL OUTPLANT PERFORMANCE OF *ACROPORA CERVICORNIS* ACROSS THREE REEF ZONES IN THE CAYMAN ISLANDS (Abstract ID: 28354 | Poster ID: 489)

To date, tens of thousands of nursery-reared staghorn coral *Acropora cervicornis* colonies have been outplanted to restore degraded reefs, largely as a result of increased capacity for coral aquaculture. The fate of outplanted colonies, however, is highly variable and seldom documented. In Little Cayman, Cayman Islands, remnant populations of staghorn coral remain in each of the reef zones where it was historically abundant. These include deep (15-20 m) and intermediate (10-15 m) spur-and-groove reefs, and especially shallow reef flats (0-3 m), where corals are known to have important wave attenuation function. To test the potential for outplanting existing nursery-reared *A. cervicornis* to each reef zone, a total of sixty ~20-cm colonies were outplanted to two plots each within the three zones of interest. Survivorship after 85 days differed significantly between zones, with mortality at deep plots exceeding that of shallow and intermediate plots. Net total linear extension of surviving colonies was significantly higher at deep and intermediate sites compared to shallow sites, which experienced a high rate of natural breakage due to wave action. Following the conclusion of the study, colonies at shallow plots experienced 90% mortality during an anomalous thermal event. Ultimately this study indicates that intermediate spur-and-groove sites in Little Cayman are most advantageous for outplanting activities using existing restoration methods. New strategies must be developed to improve *A. cervicornis* outplanting success in shallow and deep habitats.

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VARIATION IN GROWTH, BRANCHING, AND BLEACHING AMONG NURSERY-REARED STAGHORN CORAL *ACROPORA CERVICORNIS* GENOTYPES (Abstract ID: 28398)

Over the last decade, genetic factors associated with Caribbean *Acropora* restoration have received increased attention. However, quantified differences among genotypes are seldom used to inform propagation or restoration. We conducted a one-year *A. cervicornis* propagation experiment in an offshore nursery in the Florida Keys. Our objective was to quantify and document phenotypic variability among ten genotypes while they were being grown for population enhancement. Twelve non-branching, 5-cm apical fragments were taken from nursery-reared colonies of each genotype. These fragments were randomly distributed across four identical PVC tree structures for grow-out. At the start of the experiment and on ~45-day intervals, total linear extension (TLE) and branches

were quantified for each colony. Buoyant weight was measured for each colony on days 0, 122, and 336 to determine calcification rate. Bleaching was recorded on day 207 following two 10-day periods of mean daily temperature above 31°C. All affected colonies had visually recovered by day 291. Significant differences in bleaching incidence, TLE, calcification rate, and branching were detected among genotypes. Unexpected variation in *post-hoc* ranking between TLE and calcification was observed, suggesting genotype-based differences in growth strategy. This information could guide propagation and restoration using the ten study genotypes. In addition, this study may represent a model system for evaluating *A. cervicornis* genetic diversity as corals are grown for population enhancement.

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ASSESSMENT OF CORAL REEF FISH BIODIVERSITY: HOW TO CHOOSE THE RIGHT INDICES (Abstract ID: 28096)

Quantifying the biodiversity based on diversity indices is essential both for the development of effective management policies - to mitigate the loss of coral fish diversity - and to study ecological processes. We present the first representative and quantified overview of the indices used worldwide for assessing the biodiversity of coral reef fishes (from 1990 up to the present). Our aim is to assess to what extent and on the basis of which criteria the complexity of biodiversity is taken into account in coral fish studies. We found that the multicomponent aspect of biodiversity, which is considered as a key feature of biodiversity for numerous terrestrial and marine ecosystems, has been poorly taken into account in coral reef fish studies. Species richness is still strongly dominant while other diversity components, such as functional diversity, are underestimated even when functional information is available. We also demonstrate that the reason for choosing particular indices is often unclear, mainly based on empirical rationales and/or the reproduction of widespread habits, but generally with no clear relevance with regard to the aims of the studies. Finally, we propose general guidelines to serve as a basis for the selection of indices that provide complementary and relevant information for monitoring the response of coral reef fish biodiversity in the face of structuring factors (natural or anthropic). The aim of these guidelines was to achieve a better match between the properties of the selected indices and the context of each study.

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ORGANIC MATTER BIOAVAILABILITY IN THE GREAT BARRIER REEF LAGOON (Abstract ID: 28290 | Poster ID: 91)

Organic matter (OM) in coral reef ecosystems has been suggested to be a major source of energy and nutrients. However, while the importance of OM cycling for the overall biogeochemical activity has been proposed there are no studies investigating in detail the degradation of OM in reef systems. Therefore, in this study the degradation of particulate (POM) and dissolved organic matter (DOM) was followed over a 50 days period at three locations in the Great Barrier Reef lagoon, during the dry and wet seasons, in dark, temperature controlled, laboratory incubations. Our results demonstrate that the POM fraction was more bioavailable and degraded at a faster rate than the DOM compounds. The data also shows the organic matter, on average, contained more than 90% of the total bioavailable nutrients, suggesting the organic matter fraction is an important and unaccounted source, in sustaining the productivity of this coral reef system.

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A SUSPECTED NEW TROPICAL MARINE SPECIES OF AMPHIDINIUM (DINOPHYCEAE)FROM SANYA, CHINA (Abstract ID: 30170 | Poster ID: 369)

A dinoflagellate isolated from Sanya bay in China, with a minute and left-deflected epicone, was identified as a suspected new species of Amphidinium sensu stricto based on morphological and ultrastructural characters combination with LSU rDNA phylogeny. The main diacritic features distinguishing Amphidinium sp. from related taxa were: shape, size, position of distal and proximal cingulum ends, site of longitudinal flagellar insertion, sulcal course, chloroplast characteristics, and mode of cell division. In the present study, genetic phylogenetic analyses based on partial LSU rDNA using Neighbor-Joining and Maximum Likelihood revealed that Amphidinium sp. was in the monophyletic clade of Amphidinium sensu stricto, meanwhile the morphology of 16 species of Amphidinium sensu stricto were compared with the suspected new species, especially morphologically similar siblings (A. massartii, A. klebsii, A. trulla, A. gibbosum, A. carterae).

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A COMPREHENSIVE INVESTIGATION OF MESOPHOTIC CORAL ECOSYSTEMS IN THE HAWAIIAN ARCHIPELAGO (Abstract ID: 29928)

During an interdisciplinary effort spanning more than two decades, we characterized the most expansive MCEs ever recorded, with vast macroalgal communities and areas of 100% coral-cover between depths of 50-90 m extending for tens of km^2 in the Hawaiian Archipelago. We used a variety of sensors and data gathering techniques to establish geophysical, biodiversity patterns, population dynamics, and trophic dynamics of algae, corals, fishes and invertebrates in reef-associated habitats down to 150 m. MCEs are associated with clear water and suitable substrate. In comparison to shallow reefs in the Hawaiian Archipelago, inhabitants of MCEs have lower total diversity, harbor new and unique species, and have higher rates of endemism in fishes. Fish species present in shallow and MCE depths have similar population and trophic (except benthic invertivores) structures and high genetic connectivity with lower fecundity at MCE depths. MCEs in Hawai'i are widespread but associated with particular geophysical characteristics. High genetic, ecological and trophic connectivity establish the potential for MCEs to serve as refugia for some species, but our results question the premise that MCEs are more resilient than shallow reefs. We found that endemism within MCEs increases with depth, and our results do not support suggestions of a global faunal break at 60 m. Our findings enhance the scientific foundations for conservation and management of MCEs, and provide a template for future interdisciplinary research on MCEs worldwide.

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LATITUDINAL PATTERNS OF REEF FISH FEEDING ON THE BENTHOS IN CHANGING ECOSYSTEMS (Abstract ID: 28712)

Reef fish feeding on the benthos strongly affect ecosystem functioning on coral reefs worldwide. Fish species and feeding intensity can vary with several factors including temperature, depth, human-related impacts and biogeographic history. Large-scale latitudinal comparisons across natural gradients can enhance our understanding of these interactions in changing ecosystems. We addressed latitudinal variation of reef fish feeding on the benthos in terms of intensity, functional and taxonomic composition in 16 locations comprising different biogeographic provinces between latitudes 34°N and 27°S in the Western Atlantic. Feeding pressure on the benthos per unit of time and area was determined using video recordings where we could determine both biomass and bite rates of individual fishes. Feeding intensity was higher in the tropical region and decreased towards extratropical regions in both hemispheres. There was a consistent shift in the predominance of feeding pressure by herbivorous functional groups in the tropics to omnivorous groups in extratropical regions. Composition of feeding pressure by functional group was more similar within regions of similar temperature than biogeography, whereas in terms of species there was a clear biogeographic footprint. Species identity and their relative contribution within functional groups differed between biogeographic provinces. These results can be used to create predictive models of the impact of global changes in reef fish feeding, accounting for potential species range expansions and their impact on the ecosystem.

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ENVIRONMENTALLY RELEVANT CONCENTRATIONS OF MICROPLASTIC PARTICLES INFLUENCE REEF FISH ECOLOGY (Abstract ID: 28053)

The widespread occurrence and accumulation of plastic waste in the environment has become a growing global concern over the past decade. While some marine organisms have been shown to ingest plastic few studies have investigated the ecological effects of plastic waste on animals. Here we show that exposure to environmentally relevant concentrations of microplastic polystyrene particles (200-300 µm) inhibits hatching, decreases growth rates and alters feeding preferences and innate behaviors of the spiny Chromis (Acanthochromis polyacanthus) larvae. Furthermore, individuals exposed to

microplastics do not respond to olfactory threat cues which greatly increases predator-induced mortality rates. Our results demonstrate that microplastic particles operate both chemically and physically on larval reef fish performance and development, which is known to have severe effects on recruitment dynamics in coral reef ecosystems.

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DISTRIBUTION OF THREATENED CORAL SPECIES IN THE PARQUE NACIONAL SISTEMA ARRECIFAL VERACRUZANO, VERACRUZ, MEXICO (Abstract ID: 29677 | Poster ID: 698)

Sixty sites on 24 reefs were surveyed at the Parque Nacional Sistema Arrecifal Veracruzano (PNSAV) in the southwestern Gulf of Mexico, creating the most robust data set, known to date, on stony coral abundance, distribution, and health for the PNSAV. These data were collected to support effective management of the Park. A total of 6,231 colonies were assessed representing 30 species including six species listed as threatened under the US Endangered Species Act and the IUCN Red list. Threatened species represented 25% of all colonies recorded and at least one of these species occurred on 21 of the 24 reefs surveyed. Orbicella faveolata was the second most abundant species (17% of all species recorded). These species were widely distributed throughout the Park: O. faveolata observed at 88% of the reefs, followed by Acropora palmata (83%), O. annularis (83%), O. franksi (79%), A. cervicornis (62%) and Mycetophyllia (which were not identified to species) (29%). The colonies surveyed were large and relatively healthy: Orbicella spp. and A. palmata colonies had mean diameters over 100 cm and <40% mean mortality, A. cervicornis colonies were 50 cm and 22% mortality, and Mycetophyllia spp. were 16 cm and <6% mortality. These findings provide evidence that these coral reefs are unique having survived continuous anthropogenic impacts for hundreds of years due to their location off the coast of a large urban settlement and commercial shipping area, reinforcing the need for continued and increased protection for the entire PNSAV.

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UNCOVERING WITHIN-COLONY GENETIC DIVERSITY USING HIGH-THROUGHPUT SEQUENCING DATA OF CORALS (Abstract ID: 28276)

Genetic mutations provide variability upon which selection acts, and are thus an essential quality for adaptation. High-throughput sequencing generates genomic datasets from which we can identify single nucleotide polymorphisms (SNPs) among samples. These analyses have been done frequently across coral colonies, but not from multiple samples within a single colony. Because coral polyps within a colony are typically asexual clones, intra-colony genetic differences most likely arise from somatic mutations during growth. We analyzed genotype calls of samples from 23*Acropora hyacinthus* colonies and 36 *Acropora nana* colonies. The *A. hyacinthus* analysis involved 4 to 22 samples per colony, while the *A. nana*analysis included 4 samples per colony. Using the Genome Analysis Toolkit (GATK), we compared the genotypes of all samples taken from one colony. We filtered through the SNPs called across a colony's samples to identify what we refer to as "top candidates" for true markers of intra-colony variation. This method allows us to compare relative intra-colonial diversity across colonies. The largest, oldest *A. hyacinthus* colony displayed the highest rate of top candidates for somatic mutants per number of SNPs called when compared to smaller *A. hyacinthus* colonies. The diversity generated by somatic mutations may represent an additional source of adaptive potential for coral colonies as their environments are altered by climate change.

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INTRACOLONY VARIABILITY OF THE PHOTOSYNTHETIC PERFORMANCE AND ENERGY BALANCE IN THE SCLERACTINIAN CORAL ORBICELLA FAVEOLATA (Abstract ID: 28452)

The incidence of solar radiation on coral surface is highly variable across massive colonies, where changes of inclination play an important role. To analyze the effect of surface inclination on the holobiont physiology, we exposed fragments of the scleractinian coral Orbicella faveolata to 5 inclinations from 0° to 90°, reproducing a light gradient of an order of magnitude variation. A linear correlation was found between the inclination angle and the light intensity, more likely due to a high diffuse-light component on less irradiated surfaces. Photosynthetic descriptors showed important changes in the photoacclimatory response of the holobiont. This plasticity allowed vertical oriented surfaces to achieve a positive carbon balance during part of the daytime, albeit photosynthesis was never saturated and barely exceeded the compensation irradiance. By contrast, horizontal high-irradiated surfaces that were under photosynthesis saturation during most daytime showed the highest saturation values (Ek) and the lowest absorptance. This enabled holobionts to reduce the absorption of excess light energy, and hence the metabolic costs of photoprotection and repair of Symbiodinium. We concluded that coral surface inclination determines significant intracolony changes in the holobiont physiological condition to enhance the energetic balance of massive species. This plasticity may be a key to explain the intracolony variation in dominant symbionts, as well as the different physiological responses to thermal-stress or other environmental factors in coral colonies.

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A CASE STUDY OF ECOSYSTEM-BASED FISHERIES MANAGEMENT IN PUERTO RICO: THE IDEAL AND THE REAL. (Abstract ID: 29203)

Ecosystem-based fisheries management (EBFM) is gaining popularity as an alternative to traditional fisheries management approaches. In western Puerto Rico, the Abrir La Sierra, Bajo de Sico, and Tourmaline (ABT) Spawning Aggregation Areas share management between Puerto Rico and the Caribbean Fishery Management Council. Included within the boundaries of ABT are areas of ecological, social, and economic importance, including mesophotic reefs, multi-species spawning grounds, and traditional fishing areas, making the ABT an optimal candidate for EBFM. To advance EBFM in ABT, new management approaches were recently proposed for these areas, which have been traditionally managed by focusing on single species or particular habitats. However, due to competing interests from multiple user groups, fear of loss of resource access, the perception that there is not enough background information to justify changes in management, and a lack of interest for compromising or addressing trade-offs within the ecosystem, the proposal was unsuccessful. This outcome demonstrates the difficulties and challenges of advancing EBFM in the U.S. Caribbean. We discuss why, even when National Marine Fisheries Service EBFM policy is established, it may be difficult to implement because of the current management framework and the constraints inherent in that management. We also discuss communication difficulties within a cross-cultural environment, and the steps that fisheries managers and constituents are taking to resolve these difficulties and advance the application of EBFM in U.S. Caribbean waters.

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COAST-REEF SCALE PHYSIOLOGICAL RESPONSES OF ACROPORA MURICATA HARBORING SIMILAR SYMBIODINIUM GENOTYPES (Abstract ID: 29413)

Coral bleaching events are increasing worldwide as a result of climate change. Coral show differential bleaching susceptibilities depending on host and/or symbiont responses to changing environmental factors. Coral responses have been shown to vary over broad geographical scales with thermally-disparate environments. Of these responses, physiological characteristics such as Symbiodinium density and size, chlorophyll a content and estimated productivity along a coast-reef scale (<1 km) remain to be thoroughly studied. In this study, we examined these characteristics seasonally in Acropora muricata colonies that harbor similar symbiont genotypes along a coast-reef scale in Belle Mare lagoon, Mauritius. The studied reef and near-coast habitats displayed contrasting environmental conditions and bleaching histories with bleaching occurring only at the reef in 2009. We observed similar symbiont densities and cell sizes, albeit with seasonal variation, within corals from both stations. Chlorophyll a content was 30-31% lower in reef than near-coast colonies, irrespective of sampling season. Chlorophyll a content was significantly influenced by station. Estimated productivity was influenced by prevailing environmental conditions, with summer samples of near-coast colonies displaying 52% higher values than reef colony samples. This significant difference was maintained but less pronounced (18%) in winter samples. Our data suggest that similar Symbiodinium genotypes may show physiological acclimatization along a coast-reef scale as a consequence of variable environmental conditions.

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HIGHEST SPECIES DIVERSITY OF OCTOCORALS FOUND IN CARIBBEAN AND A NEW VARIABLE NUCLEAR MARKER FOR THE OCTOCORALLIA? (Abstract ID: 28728)

We have observed the highest recorded octocoral diversity in the Caribbean around the Honduran island of Utila, the eastern-most extent of the Meso-American Barrier Reef System. Additionally, the nuclear gene, ALG11, has been tested for its barcoding accuracy for the first time in Cnidaria. Originally tested in sponges, ALG11 was considered

a potential barcoding marker for slow-evolving mitochondrial organisms (Belinky et al., 2012). Extensive unresolved relationships between species exist within octocorals or 'soft corals'. We studied a group of common Caribbean gorgonians, chiefly of the species-rich genus Eunicea and compared its phylogenetic potential with current mitochondrial marker genes mtMutS and COI. ALG11 proved to be significantly more variable than mtMutS and COI combined, and is a potential candidate for population genetic studies. Morphological and ecological differences are related to genetic characters such as well-established adaptations to depth (Prada et al., 2008). Intensive morphometric analysis is included in a detailed inter and intra-species phylogeny to investigate character states that could identify molecular differences. References BELINKY, F., A. SZITENBERG, I. GOLDFARB, T. FELDSTEIN, G. WORHEIDE, M. ILAN & D. HUCHON 2012. ALG11.A new variable DNA marker for sponge phylogeny: comparison of phylogenetic performances with the 18S rDNA and the COI gene. Molecular Phylogenetics and Evolution, 63, 702-13. PRADA, C., N.V. SCHIZAS & P.M. YOSHIOKA 2008. Phenotypic plasticity or speciation? A case from a clonal marine organism. BMC Evol Biol, 8, 1-19.

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DIVE TOURISM AND ITS IMPACT ON INTEGRATED COASTAL MANAGEMENT AND LIVELIHOODS FOR ARTISANAL FISHERS (Abstract ID: 27903)

The Coral Triangle, home to the most biodiverse coral reefs in the world with more than 600 coral species and 3000 fish species, encompasses Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands and Timor Leste. These countries have formed the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security to conserve coral reefs. Over 240 million people rely on Coral Triangle coral reefs for income and food security, yet they are threatened by destructive fishing and other impacts. Dive tourism is cited for its capacity to conserve coral reefs and diversify the livelihoods of artisanal fishers, reducing their reliance on fishing for income and food security. Because it is not known whether dive tourism contributes significantly to conservation, livelihoods, or reduction of destructive fishing; or the extent to which traditional marine tenure is supported, we survey dive operators in the Coral Triangle, using an integrated coastal management framework. Our preliminary findings are that some dive operators do little for conservation, livelihoods or reduction of destructive fishing; and fail to recognise traditional marine tenure. In contrast, a few dive operators make major contributions to integrated coastal management by recognising traditional marine tenure and working with fishers as stakeholders. Our study analyses factors that lead to success in dive tourism's contribution to integrated coastal management and the extent to which success can be replicated. We also outline three case studies of best practice in the Coral Triangle and the Pacific.
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COLONY SIZE-FREQUENCY DISTRIBUTION OF POCILLOPORID JUVENILE CORALS ALONG A NATURAL ENVIRONMENTAL GRADIENT IN THE RED SEA (Abstract ID: 28435 | Poster ID: 289)

Coral colony size-frequency distributions can be used to assess population responses to local environmental conditions and disturbances. In this study, we surveyed juvenile pocilloporids, herbivorous fish densities, and algal cover in the central and southern Saudi Arabian Red Sea. We sampled nine reefs with different disturbance histories along a north–south natural gradient of physicochemical conditions (higher salinity and wider temperature fluctuations in the north, and higher turbidity and productivity in the south). Since coral populations with negatively skewed size-frequency distributions have been associated with unfavorable environmental conditions, we expected to find more negative distributions in the southern Red Sea, where corals are potentially experiencing suboptimal conditions. Although juvenile coral and parrotfish densities differed significantly between the two regions, mean colony size and size-frequency distributions did not. Results suggest that pocilloporid colony size-frequency distribution may not be an accurate indicator of differences in biological or oceanographic conditions in the Red Sea.

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DOES CORAL REEF STRUCTURAL COMPLEXITY AFFECT DENSITY OR TROPHIC LEVEL OF A HABITAT-SPECIALIST SPINY LOBSTER? (Abstract ID: 28810 | Poster ID: 296)

The spotted spiny lobster, Panulirus guttatus, is a sedentary, obligate Caribbean coral reef-dweller with a limited home range. To explore whether loss of reef structural complexity could potentially affect populations of this habitat specialist, we selected two separate coral reef patches (11,200 and 14,000 m2 in surface area) in Puerto Morelos (Mexico) and assessed their structural complexity using the rugosity index and the habitat assessment score (HAS). In each reef, we estimated density of P. guttatus with belt transects and sampled 30 lobsters to compare their stomach contents, three condition indices (weight/carapace length ratio, hepatosomatic index, blood refractive index), and stable isotope values (delta15N and delta13C). Rugosity index and HAS differed significantly between reef patches, but the less complex patch, though more flattened, still exhibited many crevices (potential shelters); hence, lobster density did not vary with reef patch. Lobsters consumed many food types, particularly mollusks and crustaceans, but consumed proportionally more coralline algae and fewer crustaceans in the more complex patch relative to the less complex patch. Lobsters in both reefs had a similar condition (all three indices) and trophic level, as suggested by similar mean delta15N values, but differed in mean delta13C values, indicating differences in organic carbon sources between reefs. Our results suggest that loss of structural complexity, at least to the degree of our less complex patch, has no apparent effects on density, condition, or trophic level of P. guttatus.

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INVESTIGATING THE EFFECTS OF SUBMARINE GROUNDWATER DISCHARGE (SGD) ON CORAL GROWTH AND BIOEROSION ON TWO SHALLOW REEF FLATS IN MAUNALUA BAY, OAHU. (Abstract ID: 29687)

Coastal marine ecosystems exist in highly variable physicochemical environments due to biological processes, restricted water motion, terrestrial influences, and feedbacks between benthic productivity and reef calcification. This variability can be augmented by land-based nutrient inputs, which increase productivity and alter carbonate chemistry. Because there is a strong relationship between carbonate parameters, such as pH, and coral calcification and bioerosion, nutrients can impact the accretion-erosion balance on coral reefs. Submarine groundwater discharge (SGD) is a common source of nutrient-rich water into shallow reef systems, yet we know little about how SGD influences coral growth and bioerosion. We used natural SGD gradients at two sites in Maunalua Bay, Oahu to assess the effect of SGD on coral growth and reef bioerosion. Coral nubbins (Porites lobata) and bioerosion blocks were deployed across the gradient for six months and one year, respectively. Coral growth was determined using buoyant weights and photos; bioerosion was quantified by comparing before and after µCT scans. To describe the chemical environment created by SGD, we collected water samples (pH, total alkalinity, salinity, inorganic nutrients, and chlorophyll a) at each experimental location during high and low tide over 24 hour periods in the dry and rainy seasons. These data are crucial in helping understand the accretion-erosion dynamics of SGD-impacted reefs, especially in high islands like Hawaii, where SGD makes up a large portion of freshwater input to coastal reefs.
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TRAIT MATCHING IN REEF FISH-CORAL SPECIES ASSOCIATIONS (Abstract ID: 29827)

Reef-building corals are foundational species on coral reefs, creating a complex three-dimensional structure that offers space and food resources for a wide array of organisms, including fishes. In this study we evaluated the relative importance of species morphological, behavioural and ecological traits in determining relationships among coral species and coral-dependent fishes using trait matching (i.e. co-occurring traits of corals and fishes in interacting species pairs). Identifying the traits associated with interacting species pairs, and whether these interactions are general or obligatory, will shed light on how the loss of coral species influences the fish community. We compiled literature records of associations between fishes and corals and combined these with coral and fish trait databases. Using generalised mixed-effects models, we show that trait matching between species pairs predict species associations better than analysing traits of corals and fishes separately. More specifically, matching levels of coral growth form and fish body size were the best predictors of species interactions. We suggest that matching traits of interacting species potentially can reveal the mechanisms behind close

relationships between fishes and corals. The identification of interdependences between functional traits of interacting species is important for predicting the outcome of species loss due to environmental change.

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UNMANNED AIRCRAFT SYSTEMS (UAS) FOR COASTAL AND REEF ECOSYSTEM MONITORING AND FISHPOND ARCHAEOLOGICAL SURVEYS OFF LANA'I, HAWAII (Abstract ID: 29974)

The east coast of Lana'i is flanked by extensive shallow reefs and five traditional fishponds. However, the reef ecosystems of Lana'i remain among the least studied in Hawaii. Historical land use on Lana'i included significant destruction of the native flora by cattle, sheep and goats, followed by pineapple monoculture. In many areas the island was left with bare soil. This not only increased sediment runoff onto reefs, but also reduced the ability of the land to absorb water thereby reducing submarine backreef spring nutrient inputs to coastal waters. The past 20 years of land development on Lana'i further exacerbated soil runoff during heavy rains. We describe use of VTOL (Vertical Take Off and Landing) unmanned aircraft systems (UAS) with video cameras as a rapidly deployed tool for monitoring both sediment runoff and reef ecosystem health on Lana'i. This included assessing UAS multispectral imaging to quantify the temporal variability of groundwater inputs to the reef. We also discuss coordination with the Lana'i Cultural Heritage Center and Lana'i City High School using unmanned aircraft to map the island's five traditional fishponds. The ability of UAS to be rapidly deployed and cover extensive coastal areas in a single day was demonstrated as a valuable tool for monitoring runoff and reef ecosystems of Lana'i.

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TO BE, OR NOT TO BE NOTICED: THE IMPORTANCE OF SPICULAR ANALYSIS FOR RECONSTRUCTIONS OF SPONGE COMMUNITIES IN MODERN CORAL REEFS (Abstract ID: 27814)

Sponges are a key and inseparable component of modern coral reefs. The knowledge of their taxonomic diversity is thus crucial for ecological considerations of these ecosystems. However, some sponge species might be easily overlooked due to their cryptic and/or excavating nature. This problem might often be solved using the method of spicular analysis. It enables to recognize spicule morphotypes by means of detailed examination of surficial sediments. Here, the spicular analysis has been applied to study the sponge-spicule assemblage in the lagoon reef of Bocas del Toro, Panama. The method allowed to identify some highly diagnostic spicule morphotypes. They belong to four sponge species, i.e. *Samus anonymus,Triptolemma endolithicum*, *Cliona mucronata*, and *Alectona wallichii*, that have not been noticed in this area so far. The last two of them were previously known only from Indian Ocean, and Japanese and South African waters, respectively. The presence of these species enriches our knowledge of the ecological interactions within the coral reef ecosystem of the studied area. Despite some limitations, the method of spicular analysis proves to be useful as a supplementary tool for the reconstruction of modern shallow-water sponge communities.

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CORALLIVOROUS FISH PREY ON PORITES LOBATA AT SOUTH JAVA SEA, INDONESIA (Abstract ID: 29454 | Poster ID: 127)

South Java sea (8o23'48.73" S; 112o31'3.59" E) is directly adjacent with the Indian Ocean that has big waves and strong currents. This condition became main factor that only massive coral can growing well and dominate than other coral life form. Poritiids and Faviids coral were found abundant in this area. One of bio-eroder of coral reef is corallivorous fishes. There are about 128 species of corallivorous fishes from 11 different families. Impact of fish bites in coral were became threat of degradation of living coral cover due to the spread of disease and wound in colonies of coral. We observed the fish bite for 14 months (April 2014 - May 2015) on 4 colonies of Porites lobata. Each colony was divided into three plots, the upper part (A), middle part (T) and bottom part (B), on each plot was divided into 4 sub-plots. Then We recorded all various bites mark in each sub-plot using underwater camera and classified as new bytes, old bites and recovery. The total amount of fish bites was 4,315 for 14 months or 25.7 bites/ month. The highest coral bite was in November 2014, with 409 new bites. The most bites were found on upper part (A) area (1,913 bites), second one on middle part (T) area (1,441 bites) and the fewest on the bottom part (B) area (961). There were three species of fish that prey on Porites lobata i.e. Parrot fish (Scaridae), Trigger fish (Balistidae) and butterfly fish (Chaetodontidae). Parrotfish prefer to eat the algae which was located in the middle part, probably that were many algae attached in this part and naturally parrot fish prey always on schooling

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CORAL NITROGEN HETEROTROPHY VS. AUTOTROPHY ON A CENTRAL EQUATORIAL PACIFIC REEF: A NATURAL ABUNDANCE STABLE ISOTOPE APPROACH (Abstract ID: 29818 | Poster ID: 87)

Laboratory coral culture experiments have suggested that the coral symbiotic system is capable of both assimilating dissolved inorganic nitrogen (DIN) from ambient seawater via zooxanthellae (N autotrophy) and acquiring N from heterotrophic feeding (N heterotrophy). However, it remains poorly understood which serves as the primary N source for reefs in different ocean environments. In the central equatorial Pacific, corals experience a natural dynamic range of ambient DIN concentrations modulated by ENSO. It provides a site to study the relative sensitivities of N heterotrophy and autotrophy to corals' N sources, because (1) both DIN and food are available; (2) DIN changes greatly from El Niño to La Niña years; and (3) due to the incomplete surface DIN consumption in the equatorial Pacific, natural abundance 15N/14N ratios (d15N) can be used to distinguish between the autotrophic and heterotrophic N sources. Previous measurements from Jarvis Island (160 W, 0.5 S) have shown nitrate concentrations to be as high as 16 uM (La Niña, 2008) and as low as 3 uM (moderate El Niño, 2010). In our most recent sampling campaign in Nov. 2015, when El Niño strength was at its highest since 1998, we found especially low DIN concentrations in the reef water, <1 uM. We will report d15N measurements of nitrate and nitrite, particulate organic matter and size-fractionated plankton, as well as the d15N of coral tissue and zooxanthellae. These data will be discussed in terms of their implications for the relative importance of N autotrophy and heterotrophy by the corals.

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A POLYP FROM NOTHING: THE EXTREME REGENERATION CAPACITY OF THE INVASIVE SUN CORALS *TUBASTRAEA COCCINEA* AND *T. TAGUSENSIS* (Abstract ID: 29393 | Poster ID: 225)

*Tubastraea coccinea* and *T. tagusensis* are within the marine invasive species that most dramatically changed the diversity in shallow-waters along São Paulo coastline. In additional to rapid settlement and growth that facilitate their spread and substrate dominance, some *Tubastraea* spp. polyps at Búzios Island were observed recovering from fragmentation. Moreover, on the sandy substrate below these colonies, small solitary polyps were found. To better understand this regeneration capacity, colonies of both species were fragmented into pieces, and its regeneration ability was tested in terms of food supply (unfed and fed), temperature (24°C, 27°C and 30°C), and fragment size (small - 6.9±1.96 mm² and large - 22.15±9.2 mm²). Within the 240 fragments, 83% fully regenerated into one or more new viable polyps. The minimum fragment size that enabled regeneration was 3.51 mm² and, overall, live tissue retreated around 45% and 51% respectively in *T. tagusensis* and *T. coccinea*, before tissue re-organization into a new polyp. The regeneration was more successful on lower temperature, in unfed larger fragments. However, it was slower if compared to higher temperatures (about 8 days faster in 27-30°C) and the effect of food supply was species specific (faster to *T. coccinea* and *T. tagusensis* can be formed from the regeneration of small skeleton fragments containing tissue, enhancing the chances of survival after injury and adding another mechanism contributing to their invasive success.

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INTEGRATING CORAL LARVAE INTO POLICY COMPLIANCE USING BULK PLANKTONIC SAMPLES FOUND PEAK LARVAL DENSITY OF 600 PER CUBIC METER, 9 DAYS AFTER THE FULL MOON (Abstract ID: 29892 | Poster ID: 701)

Environmental policy implementation is confronted with difficult and uncomfortable challenges when dealing with coral larvae. Particularly for species protected by the US Endangered Species Act (ESA). This study presents coral larvae density data collected from plankton tows to predict the potential impacts of entraining a large volume of cool-

ing water at a proposed offshore facility near the Jobos Bay National Estuarine Research Reserve, Puerto Rico. Sampling of coral larvae in pelagic waters has not been widely performed. Our approach used 200 µm mesh plankton tows, targeted the surface and 8 m depth, roughly 40 m3, occurred day and night, and counted larvae while live. Surveys in August, September, and October 2015 captured statistically genuine peaks in larval density for August and September, each lasting about 5 days centered about 9 days after the full moon. Coral larvae density ranged from 446 to 6,532 individuals per 100 m3 during peaks and 0 to 83 ind/100m3 off-peak. Densities in October did not exceed 290 ind/100m3 and planktonic coral larvae were noted in November but not enumerated. There was no statistical difference between day and night samples, and densities at the surface were about 50% less than at depth. Modeling based on the reproductive biomass at nearby reefs suggests that about 9% of these larvae could be ESA Threatened species. This study culminates with leading-edge policy implementation guidance representing close coordination with NMFS and EPA that maximizes opportunities to avoid and minimize impacts to ESA-listed corals at their larval stage.

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EXPANDING THE REEF RESTORATION TOOL BOX: DEVELOPMENT OF A NEW INVSIVE ALGAE CONTROL METHOD IN HAWAII (Abstract ID: 29105)

The Nature Conservancy (TNC), along with partners at the Hawaii Division of Aquatic Resources, is actively trying to control the spread of *Eucheuma deniticulum*, an invasive non-native alga currently restricted to Kaneohe Bay. Using a combination of mechanical (i.e., an underwater "vacuum" called the Super Sucker) and hand removal, followed by outplanting of cultured, native sea urchins to control regrowth (the Super Sucker method), *Eucheuma* cover on treated reefs can be reduced to <5% cover. Unfortunately, sea urchin propagation has not keep pace with clearing activities, necessitating the development of a method that does not require sea urchin outplanting to be successful. In response, TNC developed and tested a new *Eucheuma* control method (the 100% Clear) on Koamano, a 0.45 ha patch reef in Kaneohe Bay. For this method, control crews used fine tools to remove all *Eucheuma*fragments from the reef (over 450 kg of algae), theoretically eliminating the need for sea urchin outplanting. After 12 months, *Eucheuma* regrowth on Koamano was negligible compared to control plots where algae regrew to pre-clearance levels in 4-6 months. Permanent photo-quadrats on Koamano documented coral tissue regrowth in "dead areas" following removal of overgrowing *Eucheuma*, conclusively demonstrating positive benefits of algae removal. While time needed to clear the reef was greater for the 100% Clear than the Super Sucker method, time and cost savings were realized during post-clearing maintenance, making the 100% Clear method a viable alternative for invasive algae control.

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CONTINENTAL SCALE ESTUARINE WATER QUALITY TRENDS FROM REMOTE SENSING TIME SERIES (Abstract ID: 29034 | Poster ID: 543)

The relationship between reefs and water quality is well studied, and has led to an intensive effort in many places worldwide to mitigate and eliminate both point- and diffuse-source pollution. Monitoring the efficacy of palliative action on water quality can be difficult, and is a significant issue in Australia, since the whole gamut of reef types exist along its extensive and often isolated coastline. Gauging station data has high accuracy and temporal resolution, but the spatial coverage is poor and is often limited to upstream water quality. Water quality data has been successfully derived from satellite data for deeper coastal waters, but has yet to provide consistent information at the coastal interface. There have been many local scale empirical studies looking at individual estuary or reef systems, but as yet there has not been a consistent analysis over large spatial scales (i.e. continental). We demonstrate analysis of water quality trends for all estuaries in Australia defined by OzCoasts (~600) from 1987 to 2015. We obtained time-series stacks of Landsat reflectance for each estuary via Geoscience Australia's *Data Cube* infrastructure, which included data from the TM, ETM+ and OLI sensors. We used simple analytical water quality metrics to explore various trends and hypotheses with smoothing techniques and linear models. Models ranged from simple linear models with a single linear term, to generalised additive models, with both fixed and random effects, including terms to account for seasonality, catchment properties, as well as estuary type, size, and status.

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THE EFFECTIVENESS OF MARINE PROTECTED AREAS ON CONSERVING THE FISH POPULATION IN THE GULF OF AQABA, EGYPT. (Abstract ID: 28339)

Fisheries on the Egyptian coast of the Gulf of Aqaba are conducted mainly by the local community (Bedouin). It is a traditional activity where fish are mainly used for subsistence and the surplus consider a source of income. As part of the effort of the Egyptian government to protect the coral reef ecosystem and maintain this traditional activities, a network of three Marine Protected Areas in the Gulf of Aqaba were established. In this study, we investigated the change in diversity, density and size of fish populations (9 families) over 10 years (2002-2012) of conservation efforts in the Gulf of Aqaba. Four regions were studied, with different level of protection and fishing pressure. We found that Nabq decreased significantly in total species by 2012, while Dahab significantly increased in both total species and diversity. Nabq and Ras Mohamed National Park decreased significantly in fish abundance by 51% and 39% respectively while Dahab the least region in fish abundance increased by 75% over time. Size of the target herbivore and carnivore species were significantly decreased over time with Nabq and Dahab having the smallest fish size by the end of our study. Fishing pressure has been increasing in Nabq and affecting the fish population dramatically, due to Dahab fishers and non-compliance by fishing the No Take Zones, even in the Ras Mohamed National Park, fishing occurred causing decline in abundance of target species. Ensuring long term effective law enforcement is critical for the Marine Protected Areas to maintain the fish populations in the Gulf of Aqaba.

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ECOLOGICAL DETERMINANTS OF DEPTH RANGES IN CORAL-FEEDING BUTTERFLYFISH: ARE DEEP REEFS A REFUGE? (Abstract ID: 28143)

Declining coral abundance on many reefs globally is altering the composition of coral reef fish communities. Many reef fish species depend on live coral for a range of ecological processes, but coral specialists such as obligate coral feeders are among the most threatened. The most severe declines in coral abundance often occur in shallow water and deeper reefs may therefore provide a refuge for reef fish if they can maintain suitable stable habitat in the face of shallow water reef degradation. However, the ecological factors influencing depth distributions in coral reef fishes are currently poorly understood, and our ability to assess the depth refuge potential has therefore been limited. Here, we analyse how resource use, territorial area, territorial behavior, movement, and body condition of an obligate coral feeding butterflyfish species varies along a depth gradient from 0-40m. We relate patterns in these behaviours to changes in the availability and nutritional quality of food sources along the depth gradient and across time to demonstrate that suitable deep-water habitat can provide a refuge for an obligate coral feeding reef fish in a clear-water, low-latitude reef system.
http://www.coralcoe.org.au

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A NEW WAY OF MEASURING CORAL HEALTH AT LAOLAO BAY, SAIPAN. (Abstract ID: 29860)

Coral reef health in Laolao Bay, Saipan, Commonwealth of the Northern Mariana Islands has deteriorated over the past several decades due to resource over-harvesting, land-based sources of pollution, and climate change. The Bay is most susceptible to effects of land-based sources of pollution, such as sedimentation and polluted runoff. Corals respond physiologically to environmental stress by increasing or decreasing levels of various regulatory proteins or biomarkers. Heat-shock proteins and detoxification enzymes are examples of proteins used by corals to cope with heat or toxicant stress. These molecular biomarkers can be quantified and used by managers to evaluate coral health. Local government agencies have begun to restore the Laolao Bay watershed in hopes of improving coastal water quality and associated coral reef health in Laolao Bay. My research will investigate the change of coral health in response to the Laolao Bay watershed restoration project. Stress-associated biomarkers in the reef coral*Porites lobata* will be quantified from samples collected before and after the restoration project. The results of this study will 1) provide resource managers with key information on the specific stressors affecting the corals studied and 2) provide baseline information for future comparison and for tracking the effectiveness of land-based mitigation measures. Knowing the causal effects of coral stress is important for the "real time" conservation and management of Laolao Bay coral reef ecosystem.

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COOPERATIVE PARTNERSHIP FOR CORAL REEF CONSERVATION (Abstract ID: 29807)

The Nature Conservancy and the NOAA Coral Reef Conservation Program recently completed a $10 million six-year partnership to support effective management and protection of coral reefs. The work focused on providing planning, science, and on-the-ground implementation activities in Hawaii, Commonwealth of the Northern Mariana (CNMI), American Samoa, U.S. Virgin Islands, Puerto Rico, and Florida. Successful strategies were further leveraged through global capacity building activities for coral reef managers. This presentation will outline TNC, NOAA and local resource management agency contributions to support this body of work, and will highlight processes for effective collaboration, progress made and lessons learned in the implementation of long-term cooperative agreements to build coral reef management capacity.

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FUNCTION-BASED MANAGEMENT OF MULTISPECIES REEF FISHERIES (Abstract ID: 28319)

Coral reef fisheries often include multispecies catches that are rarely well monitored, making traditional fisheries management impractical in many places. Even with some form of fisheries restriction present, it is difficult to set management objectives and evaluate their effectiveness without clear ecosystem targets. I will outline our regional and global approach to solving these problems through multiple large-scale analyses of reef fish biomass. I start by highlighting ecosystem tipping points across gradients of fishable biomass and link these to a function-based approach to fisheries management. I go on to show that while more than 80% of fished reefs have lost more than half their expected reef fish biomass, few coral reef fisheries have collapsed completely, with the majority of fished reefs maintaining important ecosystem functions above biomass levels associated with a predictable series of rapid declines. Encouragingly, the majority of reef fisheries can maintain functionality by adopting one of several management alternatives that support both livelihoods and ecosystems. This large-scale analyses provides an empirical basis for relatively simple fisheries guidelines at the local scale, conditional on factors relating to environmental setting, catch composition, and social context. Where people want to sustain their fisheries and are willing to restrict them in some way, effective multispecies reef fishery management is possible in most jurisdictions.

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TOWARDS AN EMPIRICAL DEMONSTRATION THAT HEALTHY REEFS NEED SHARKS: EMERGING POLICY AND MANAGEMENT TOOLS TO SUPPORT THE CASE FOR PROTECTION (Abstract ID: 29100)

A prevailing opinion that coral reefs can be conserved by simply protecting the grazers at lower trophic levels misses the implications of rates of energy flow on reef systems and the resultant mitigating role that reef predators such as sharks play. The relationship between top predators and coral reef health is not obvious. Until recently, scientists did not believe a coral reef could even support a large biomass of top predators because the ecological models came from grasslands with much slower rates of energy turnover. The rates at which the primary producers, sharks, and microbes are growing are the essential paths that link top predators to coral reef health. Unfortunately, compared to standing stocks of sharks and corals, rates are much harder to measure and visualize. From a conservation policy perspective, the lack of a simplified, instructive model that communicates the reality of rates and the invisibility of energy flow creates a major conceptual challenge when trying to convey the importance of sharks to mostly non-scientist policy makers. Meeting this challenge head-on, this presentation describes a pioneering collaboration currently underway between scientists and conservation professionals to bridge the conceptual hurdle of rates and energy flow on reefs through the development of an interactive online visualization tool that demonstrates the role of apex predators as energy sinks and mediators of reef health. We also propose an assessment of jurisdictions most receptive to stronger legislative protection of sharks as a result of this new understanding.

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PERSISTING *TERPIOS HOSHINOTA* OUTBREAKS IN INDONESIAN REEFS – PROLIFERATION, INVASION OR TRANSITION? (Abstract ID: 28472 | Poster ID: 72)

Proliferative growth of *Terpios hoshinota* in a coral reef was first reported by Bryan (1973) in Guam, Northern Marianas. Since then, outbreaks of the encrusting and coral-killing sponge have been observed at numerous Western Pacific sub-tropical and tropical locations. Previous studies on *T. hoshinota* have suggested that the sponge is currently widening its geographical range, but that *Terpios* outbreaks may be sporadic and reversible in nature. In Indonesian waters, the so-called black disease sponge has been reported only recently. From 2013 to 2015 we surveyed coral reefs across the Indonesian archipelago for Terpios hoshinota. These surveys revealed that the sponge so far has been severely underreported in Indonesia. Alarmed by these frequent occurrences and their wide geographical range. With our present survey we have shown that under certain circumstances outbreaks may persist over several years. Consistent with previous studies, the sites where we found high abundances of Terpios where characterized by high nutrient levels, high turbidity, and extensive physical destruction to the reef. The numerous discoveries of Terpios in our survey may be interpreted as corroboration of this hypothesis, but may also be explained by the proliferation of a native species or simply by the fact that the sponge has recently been more frequently recognized because it is has received a wider attention. Coral reefs may undergo a phase-shift towards sponge-dominated reefs and a proliferation of Terpios on reefs may be one indication of such a global transition.

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THE PULLEY RIDGE INTERACTIVE DECISION SUPPORT RESOURCE (DSR) (Abstract ID: 29536 | Poster ID: 190)

*Connectivity of the Pulley Ridge - South Florida Coral Reef Ecosystem: Process to Decision-Support Tools*, is studying the Pulley Ridge mesophotic coral community in order to better understand its connection to the ecosystems of the Florida Keys National Marine Sanctuary, other ecosystems in Florida, the Gulf of Mexico, Bahamas, and Caribbean region. The results of this study will improve understanding of the physical and ecological processes that affect Pulley Ridge. This improved understanding can then inform decision making regarding management, conservation or protection of Pulley Ridge based on its connections to other communities in the region. As part of this project, the Pulley Ridge Decision Support Resource (DSR) is being developed to provide comprehensive access to scientific data and analyses generated by the project. This publicly available web-based application is written in Java, Javascript, and HTML, and makes use of Apache Solr to provide a rich user interface and rapid search capabilities. Users may search across datasets, view previews and summaries of dataset contents, as well as access and download published data, model output and analyses using text, concept and map-based searches.

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A TRAIT-BASED APPROACH TO ADVANCE CORAL REEF SCIENCE (Abstract ID: 28507)

Modern coral reefs are biologically diverse and ecologically complex ecosystems constructed by stony corals. Despite decades of research, basic questions relating to coral population biology and community ecology remain unanswered. Trait-based research can lead to improved understanding and management of ecological systems, which is vital in the current era of rapid environmental change. Here, we first present a database of species- and individual-level information from published field and experimental studies alongside contextual data that provide important milieu for analysis. The Coral Trait Database (https://coraltraits.org) is an open-source clearinghouse that welcomes contributions and improvements from the community. We contend that progress in addressing basic questions in population biology and community ecology has been hampered by a paucity of trait data for many, often rare, species and reliance on non-quantitative approaches. Therefore, we present an approach that focuses on filling data gaps by prioritizing traits that are easy to measure, estimating key traits and vital rates for species with missing data, and identifying "super-traits" that capture a large amount of variation for a broad range of biological, ecological and evolutionary processes. We believe that such approaches will accelerate our understanding of coral biology and ecology, and therefore our ability to protect this critically threatened global ecosystem.
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THE ENIGMATIC DIVERSITY OF SCLERACTINIAN-ASSOCIATED HYDROZOANS (Abstract ID: 28337)

Scleractinian reef corals are able to establish intimate associations with several organisms. Recently, hydrozoans have been included into the plethora of coral symbionts. These poorly known hydrozoans belong to the genus *Zanclea* and are strictly associated with their hosts, growing partially embedded by coral tissues. In this work, we evaluated the ecology and the diversity of this symbiosis through the integration of ecological, morphological and molecular approaches. Coral-associated hydrozoans were found in several geographical localities including Indo-Pacific Ocean, Atlantic Ocean and Red Sea and were associated with 29 coral host genera. According to polyps and medusae morphology, three morpho-types were identified. Nevertheless, molecular phylogenetic analyses revealed an unexpectedly high genetic diversity and several divergent molecular clades were identified. The majority of these genetic lineages were host-specific and cryptic since they were not detectable through morphological analyses. We therefore applied DNA taxonomy techniques to our dataset and we identified several independent species. With the exception of one highly generalist species, the other detected cryptic species could be identified integrating morphological characters, host genus and in few cases geographic provenience. Overall, this work suggests that these diminutive hydroids are more widespread and more commonly associated with coral than previously known and that they hide an unexpected cryptic biodiversity.

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DOES OCEAN CURRENT CONNECTIVITY PREDICT SIMILARITY OF CORAL COMMUNITY COMPOSITION IN THE INDO-PACIFIC? (Abstract ID: 29354)

The hard coral community composition of reefs in the Indo-Pacific ocean exhibits a pattern of declining richness from the coral triange that appears to be non-random. The actual processes that generate the pattern are not fully understood, but the ability (or lack thereof) of larvae to disperse between reefs via ocean currents may be one of the causes. To bridge this knowledge gap, we test the extent to which coral dispersal driven by ocean currents could contribute to large-scale species distribution and richness patterns at over 10,000 reefs across the Indo-Pacific. Specifically, we test whether community similarity amongst reef clusters is predicted by networks that represent reef connectivity according to (a) geographic distance, (b) environmental similarity, and (c) ocean currents, using a combination of oceanographic modelling, spatial statistics and network analysis. Our results are expected to indicate that similarity in reef community composition is best predicted by ocean currents. This would suggest that ocean currents play an important role in coral biogeography, and that dispersal is a more influential process than environmental filtering for maintaining underlying coral species distributions that have been generated over long time scales.

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INTEGRATION OF MULTIPLE CONSERVATION OBJECTIVES IN MARINE PLANNING FOR CORAL REEFS (Abstract ID: 27773)

Decision-makers focus on representing biodiversity, maintaining connectivity, and strengthening resilience to climate warming when designing marine protected area (MPA) networks. However, the development of MPAs intended to achieve these goals might fail if multiple conservation objectives are not adequately formulated from the outset of marine planning. By using Brazilian coral reefs as a case study, we devised conservation objectives for biodiversity, connectivity and resilience to climate warming and we determined the extent to which existing MPAs achieve these objectives. In doing so, we explored interactions between different sets of objectives and evaluated the consequences of pursuing single objectives in marine planning, leaving other objectives to be achieved incidentally. We found that MPAs in Brazil are more effective for biodiversity than for connectivity and resilience to climate warming. Moreover, we identified extensive misalignment between existing MPAs and priority areas that strategically achieve a well-balanced set of objectives. Although better synergies between objectives were found when planning directly for biodiversity, multiple-objective approaches will provide the best opportunities for integrated MPA design. Our analyses reinforce the utility, feasibility, and value of setting multiple conservation objectives, support efforts to expand MPAs for Brazilian coral reefs, and yield insights for planners of coral-reef MPAs elsewhere.

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ASSESSMENT OF A BARNACLE BIOERODER AND ITS IMPACT ON A DOMINANT REEF-BUILDING CORAL FROM A HIGH CORAL COVER REEF (Abstract ID: 29765 | Poster ID: 244)

Although multiple studies use density as a proxy for the impact of macrobioeroders on a coral reef, few assess the only genus of thoracican barnacles known to burrow, *Lithotrya*. This study aims to 1) develop a procedure for quantifying *Lithotrya dorsalis* density in colonies of *Orbicella franksi* from photos of coral reef benthos, 2) describe the bioeroder's distribution within populations of this coral, and 3) determine its impact on host colony growth. We used a NOAA dataset spanning 2006-2015 collected from ~40 long-term coral reef photostations at the Flower Garden Banks (Gulf of Mexico). Log-transformed mean barnacle densities in 2014 were similar in the East and West Banks but significantly decreased with increasing colony area and depth, contradicting previous reports that density exhibited no relationship or increased with depth. Based on published modeling efforts, the 2014 size structure of *O. franksi* indicates this coral population experiences minimal disturbance. Ongoing time-series analysis is investigating how bioeroder colonization affects colony growth and population demographics from 2006-2015 photos. In past decades FGBNMS has experienced consistently high coral cover (~50%) and minimal nutrient pollution, in stark contrast to many Caribbean reefs. The methods described in this study can be extended across a spectrum of reef disturbance regimes to better understand how bioeroders impact their hosts.

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AN EMPIRICAL STUDY ON IMPACT OF DIVERS AT SIPADAN ISLAND PARK, SEMPORNA, SABAH (Abstract ID: 27970 | Poster ID: 447)

This study are to assess the dive frequency on each dive site based on the presence of iconic fishes, to investigate diver contact on the reef and to evaluate the pre diving briefing by dive operators. A total of 66,243 dives were recorded from 12 established dive sites. Four dive sites location were found to have exceeded their safe limit and the foremost popular dive site is Barracuda Point. Statistical analysis showed a the higher sightings of iconic fishes corresponded with the popular dive sites. However, the rate of sighting record was similar in all months. Diver with Open Water licence recorded the highest percentage of coral contact, followed by Advance Open Water and Rescue and higher skilled licence. No significant difference in coral contact rate by diver for different gender. Divers who dived with a big sized camera recorded highest coral contact rate which were 42.91% (N=49), followed by divers with a small sized camera with a contact of 37.27% (N=224). Diver without having any camera recorded the lowest with only 19.82% (N=590) contact. Divers are also more likely to make contact if the ratio between divemaster and divers are higher. A divemaster who dives with 8 or more divers recorded coral contact of 60.65% (N=513), while the ratio of a divemaster and divers of 5 to 7 people make contact of 49.70% (N=876). For ratio of 4 divers and a divemaster recorded lowest contact with only 45.14% (N=513). Almost all dive operators, especially the larger operators classified as Category I had low scores recorded during the pre-diving briefing evaluation.

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DESIGNING FISHERIES MANAGEMENT AREAS FOR PATE ISLAND, LAMU ARCHIPELAGO, KENYA (Abstract ID: 29410)

Fisheries resources in Kenya are facing increasing threats from overfishing and habitat destruction resulting from weak governance system and increasing demand for fisheries resources. The situation is exacerbated by impacts of climate change on marine ecosystems. One key to containing these threats could be fisheries co-management approaches that have been widely adopted internationally in response to the widespread degradation of fisheries resources. Fishing is an important source of livelihood and food security along the Kenyan coast and especially in the northern coast of Lamu. The Kenyan government has provided frameworks within which natural resources including fisheries can be co-managed more sustainably and effectively. In compliance, the fisheries Beach Management Units in Pate Island initiated the process of developing co-management plans for their respective areas. A series of community-led marine managed area planning processes were held since 2014 characterized by robust stakeholders consultations and capacity building sessions. These included input from latest science that helped inform decisions by fishers to ensure proposed rules/zones achieve desired community

benefits. Six different zones were proposed including a multi-use zone, no-take zone, species-specific zone, seasonal closure and gear restriction zone. This paper shares experiences from Pate Island where local communities and partners are taking advantage of the new innovative co-management structures and latest science to design effective fisheries co-management areas.

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ONE HUNDRED YEAR OCEAN THERMAL SIGNATURES INFORM CLIMATE RISK AND REFUGE FOR CORAL REEFS (Abstract ID: 29219)

Temperature rise is killing corals and undermining their ability to recover and provide key ecological services. However, there is growing recognition that histories of thermal variability influence ecological responses of corals and other species more than the average climatic change. Here, we deconstruct 100-year historical records of global sea surface temperature time series to derive spatially explicit thermal regimes and evaluate associations with reports of coral bleaching. Our results identified the intensity, frequency, and duration of warm and cool thermal anomalies plus time series entropy as important predictors of coral bleaching. A consensus of 4250 statistical models revealed new locations where corals may find refuge in a warming world – with approximately 100 times more predictive power than Degree Heating Month metric. We conclude that climate impact models and satellite-derived metrics of coral bleaching could be significantly improved with the addition of a long-term climate variability perspective.

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HOW ACCESSIBLE ARE CORAL REEFS TO PEOPLE? A GLOBAL ASSESSMENT BASED ON TRAVEL TIME (Abstract ID: 27807 | Poster ID: 532)

The depletion of natural resources has become a major issue in many parts of the world, with the most accessible resources being most at risk. In the terrestrial realm, resource depletion has classically been related to accessibility through road networks. By contrast, in the marine realm, the impact on living resources is often framed into the Malthusian theory of human density around ecosystems. Here, we develop a new framework to estimate the accessibility of global coral reefs using potential travel time from the nearest human settlement or market. We show that 58% of coral reefs are located less than 30min from the nearest human settlement. We use a case study from New Caledonia to demonstrate that travel time from the market is a strong predictor of fish biomass on coral reefs. We also highlight a relative deficit of protection on coral reef areas near people, with disproportional protection on reefs far from people. This suggests that conservation efforts are targeting low-conflict reefs or places that may already be receiving de facto protection due to their isolation. Our global assessment of accessibility in the marine realm is a critical step to better understand the interplay between humans and resources.

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THE REEF RESILIENCE NETWORK: CHALLENGES, LESSONS LEARNED, AND CAPACITY BUILDING RECOMMENDATIONS FOR IMPROVED GLOBAL CORAL HEALTH. (Abstract ID: 30084)

Despite contributing to human and economic health in innumerable ways, coral reefs suffer increasing degradation from man-made threats such as pollution, overfishing, and warming oceans. The Reef Resilience Network brings together resource managers, scientists and advisors, and supporting organizations to safeguard naturally resilient reefs and restore reef fisheries worldwide. The Network offers interactive webinars, an online toolkit with case studies and article summaries, a virtual discussion forum, and online and in-person trainings to enhance skills and knowledge of site-based practitioners so they can implement strategies based on the latest science. To help managers and practitioners launch or strengthen conservation education, monitoring, and threat abatement projects, the Network also sometimes provides seed funding and mentorship. This presentation will focus on challenges, lessons learned, and capacity building recommendations for improved global coral health.

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COEVOLUTION ADAPTATIONS OF BUTTERFLYFISH TO CORAL ALLELOCHEMICALS (Abstract ID: 28093 | Poster ID: 110)

Butterflyfish have coevolved with corals for millions of years, yet the evolution of this highly specialized coral consuming mode remains poorly understood. Plants and corals are sessile creatures producing allelochemicals to prevent predations. A mechanism to counter adapt and consume allelochemically-rich organism, such as soft coral Sinularia maxima, is through detoxification. Cytochrome P450 monooxygenase (CYP) is the primary enzyme system for detoxification of dietary allelochemicals. CYP2 and 3A have had some associated with butterflyfish that preferentially consumes allelochemically rich soft corals. This research shows butterflyfish CYP3A's involvement in coral allelochemical metabolism. Oral exposure to S. maxima toxin 5-episinuleptolide (5ESL) hard corals specialist Chaetodon multicinctus experienced 100% mortality compared to a generalist, Chaetodon auriga, which had significantly more CYP3A (3-6 fold higher) basal content and catalytic activity. The specialist, Chaetodon unimaculatus, which preferentially feed on S. maxima in Guam, but not in Hawaii, had 100% survival, a significant induction of 8-12 fold CYP3A, and an increased ability (2-fold) to metabolize 5ESL over other species. In vitro incubations with liver microsomes coupled with computer modeling data of CYP3A4 are consistent with the formation of 5ESL epoxide metabolite and correlated with CYP3A content, catalytic activity, induction and NADPH dependent oxidase formation. These results are a starting point for marine ecologists seeking to explain the vast differences in consumer tolerance.

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CORAL RESTORATION AND ARTIFICIAL REEFS FOR THE PROTECTION OF VAAN ISLAND, FISHERY PRODUCTION AND CLIMATE ADAPTATION – CASE STUDY FROM GULF OF MANNAR, INDIA (Abstract ID: 29262)

The Vaan Island is one of the 21 islands in Gulf of Mannar and the corals are distributed around the island. This island was the most affected in the last 4 decades because of coral mining. Erosion has been a serious threat to Vaan Island as it is shrinking in size over the years. In 1896 the Island covers an area of 16 hectres and it reduced to 2.5 hectres in 2015. Combination of several factors is responsible for fast erosion. Coral mining around the Island caused instable substratum and the change of current direction during southwest and northeast monsoons also reflects on the Island. The Tamil Nadu State Coastal Zone Management Authority has taken steps in 2015 to protect the island from further erosion. Coral restoration in 3 Km2 degraded area has been successfully conducted following transplantation technique with native coral species. Wave Dynamic and Bathymetry Studies have been conducted to design artificial reef (AR) modules and deployment location. The deployment of AR modules (each 2.5m width, 2m height and 1 m longitudinal length) parallel to Vaan Island in the seaward side of the island has been to reduce the effect of waves and currents commenced. The ARs would not only help to protect the fast eroding Vaan Island, but also enhance fish production for sustained livelihood to artisanal fishers, natural coral recruitment and climate adaptation by increasing fish habitats. The reef areas around the island are shallow predominantly with 0.5-3.0m depth and coral restoration and artificial reef would assist in the conservation of coral and associated biodiversity in particular fish population against climate variation.
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GENETICS OF ADAPTATION IN A TEMPERATE SEA ANEMONE: SEARCH FOR SELECTION AMONG ECOLOGICALLY AND MORPHOLOGICALLY DIFFERENTIATED POPULATIONS USING NGS DATA (Abstract ID: 29401)

*Anemonia viridis* is a symbiotic temperate species commonly found from the English Channel to the Mediterranean Sea from shallow water down to 30m deep as well as in lagoons. Five different morphs have been described in this species based on the expression profiles of GFP-like proteins. Two ecologically contrasted populations (shallow vs deep, open sea vs lagoon) were sampled from 5 locations, and individuals from three morphs were sampled in several locations from the English Channel and the Mediterranean Sea. In order to understand the genetic basics of adaptation to differing temperature regimes, we are scanning the genome of over nearly 400 individuals for signature of selection. We looked for Fst outliers from a pool dataset of RAD and 12 EPIC markers. Each EPIC marker targets a different gene whose expression is modified under a temperature stress, as revealed in our lab by a transcriptomic approach (Ganot et al. 2011, Moya et al. 2012). Based on a subset of individuals, preliminary results did not show any clear genetic differentiation among the morphs. Through the analysis of the whole dataset, we will answer the following questions: Is there any genetic differentiation among the morphs of *A. viridis*? Is there any genetic adaptation in this species considering the wide range of habitats it colonizes? And, finally, are stress response genes involved in local adaptation?

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FEAR AND FORAGING: REVEALED PREFERENCES OF A CORAL REEF FISH (Abstract ID: 29007)

Top-down and bottom-up processes structuring fish communities are central to coral reef fish ecology and conservation. Many studies have investigated how reef fish populations respond to bottom-up processes over time. However, less is known about top-down controls impacting fish populations. Specifically, predators and the fear of predation may greatly impact the behaviors of prey, their population dynamics, and population sizes. Previous studies interested in top-down effects looked at fish behaviors through tethering experiments. Tethering experiments, widely used to quantify foraging and predation risk, effectively document presence and foraging activity, but cannot quantify foraging costs. With depletable food patches, as shown here, we can quantify costs of foraging experimentally. We quantified risks and rewards of foraging with depletable food patches to quantify spatial and temporal preferences of fishes on patch reefs of Kaneohe Bay, Oahu, Hawaii. Food patches targeted a common benthivorous fish, Thalassoma duperrey. Optimal foraging from experimental food patches was confirmed through prey density experiments, thus validating our methodology. Results revealed on-reef foraging preferences. Early morning foraging was preferred to afternoon, and open, sandy microhabitats were preferred to sites with high rugosity. This study quantifies habitats as safe and risky as revealed through the fishes themselves. Revealed preferences through foraging behaviors can provide managers with internal state of reef inhabitants and quality of the reef from the fishes' point of view.

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A FRAMEWORK TOWARDS INTEGRATING REEF FISHERIES MANAGEMENT IN SMALL-SCALE FISHERIES IN THE TROPICS (Abstract ID: 29162)

Coral reef ecosystems provide vital goods and services to millions of people in the world. In the Philippines, where more than 50% of the total population is found along coastal areas, the dependency for these goods and services continues to rise but increasingly exacerbated by high poverty incidence especially among the small scale fishers. Further, the delivery of these goods and services is greatly hampered by the poor current state of many of its coral reefs subjected to various forms of threats such as overfishing, habitat degradation, unregulated coastal development, pollution, and recently vulnerability to climate change impacts. This requires improvement of present management strategies which can be described as weakly implemented, piecemeal and isolated, and data deficient, among others. This paper shows the utility of a conceptual framework previously developed to highlight the integration of biophysical, ecological and social aspects addressing both human (e.g. overfishing) and natural perturbations (e.g. storm surges) towards an informed management decision across varying levels of governance. In this study, the assessment of some fishing communities and their coastal habitats showed varying degrees of suitability, susceptibility, and sensitivity along the ecological-social linkage and, hence, prompts management formulation based on options from corresponding site-specific adaptation strategies.

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USING VALUE CHAIN ANALYSIS TO IMPROVE FISHERIES MANAGEMENT IN THE FIJI ISLANDS (Abstract ID: 27836)

Fiji's population is largely coastal and therefore highly reliant on inshore fisheries for their subsistence and livelihoods. However, the commercialization of resources and increased access to markets has resulted in illegal and overharvesting of coastal resources, which is impacting communities' food security, and the biodiversity and resilience of the systems that sustain them. In partnership with the Department of Fisheries, we conducted a value chain analysis (VCA) of the wild caught sea cucumber and mud crab fisheries in Fiji. VCA is a useful tool to understand the relationships between buyers, processors, sellers, and other service providers, to identify opportunities and constraints to industry growth and competitiveness. The study highlighted fisher dependency on fisheries, inequalities in income received by fishers, the role of women, market preferences and demand, as well as the obstacles to value-adding and sustainability. We also documented the socioeconomic costs to communities engaging in dangerous practices like SCUBA to harvest sea cucumbers at increasing depth. By looking at resource value and dependency through the lens of a value and supply chain analysis, we were able to better understand the linkages between fisheries and food systems and identify pathways to conservation, management and policy interventions. We also obtained a wealth of information about two invertebrate fisheries in short period of time, for relatively low costs, making VCA a useful tool in data-poor countries.

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ASSESSMENT OF THE RESILIENCE POTENTIAL OF PALK BAY REEF THROUGH KEY INDICATORS (Abstract ID: 28149 | Poster ID: 423)

Palk Bay reef in the southeast coast of India has the ecological foot prints of both climatic and anthropogenic stress leading to their continuous degradation. This study assess the recovery and resilience potential of the Palk Bay reef through key indicators. The diversity, density and overall recruitment rate of juvenile corals was low and it varied spatially along Palk Bay reef. Species diversity of juvenile corals differed from the adult corals indicating reef connectivity. In total, >90% of the juvenile corals survived the bleaching and sedimentation stress. Seasonal bloom of C. racemosa and E. flexuosa reduced the live coral and crustose coralline algal cover by 4% and 8.5% yr-1 respectively. Increased exploitation had kept the standing stock of reef herbivore fishes consistently low and this had further enhanced the colonization of turf algae over corals and other available hard substrates in Palk Bay leading to their degradation. Corals were bleached during summer and returned to their normal state without any post-bleaching mortality despite the increase in the sea surface temperature and photosynthetically active radiation in 2014 compared to 2013. Results suggest that the seasonal macroalgal bloom and reef fishing activities are the major disturbances to the corals in the Palk Bay reef hindering their natural recovery potential. Wide spread prevalence of stress tolerant coral juveniles and their ability to withstand the stress is a positive sign of resilience that will contribute to the coral dominance in the Palk Bay reef despite the prevailing disturbances.

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CQUNIVERSITY INDIGENOUS LAND AND SEA EDUCATION PROGRAM (Abstract ID: 28026)

An institution based program has been integrated with an Indigenous approach to foster environmental career development. The Indigenous Land and Sea Education Program (ILSEP) based at the Central Queensland University of Australia focuses on: Recognition of the environment; reduction of pressures and threats; and preparing for success. The program is delivered together with Traditional Owners, on-country, using Indigenous teaching approaches. Students learn to recognise biocultural values and their relevance to their everyday lives through culturally appropriate education, and the program provides support and inspiration to students to pursue their dreams and career aspira-

tions; understand and appreciate their environment; identify mentors and supports; and plan for achieving their goals. Developed by a Dharumbal Traditional Owner from the Rockhampton area in Queensland, Malcolm Mann has accrued experience in management agencies such as the Queensland Parks and Wildlife Service and Great Barrier Reef Marine Park Authority. He has developed and implemented biocultural education programs within the Great Barrier Reef World Heritage Area that aim to promote cultural awareness, a deeper awareness and an appreciation of country through traditional ecological knowledge and western understandings with a collective aim to raise the value of 'looking after country together'. In this talk, Malcom will share his learnings and experiences about bringing together traditional knowledge and education with management agencies to enhance conservation outcomes.

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DESIGNING TRANSBOUNDARY MARINE PROTECTED AREA NETWORK BETWEEN THAILAND AND MYANMAR TO BUILD ECOSYSTEM RESILIENCE AND IMPROVE CORAL REEF CONSERVATION (Abstract ID: 29423 | Poster ID: 648)

The Andaman Sea in the Bay of Bengal experienced unprecedented mass coral bleaching with very high mortality rates in 2010. Five year post-bleaching surveys in Thailand revealed that the bleaching impact was differed both at regional and local scales. Some local sites at Mu Ko Surin National Park in Thailand which lied at the border with Myanmar show most remarkable recovery and revealed the importance of protecting the sources of recovery upstream in adjacent Mergui Archipelago. In Thailand, twenty-two indicators were identified through a participatory workshop with local experts to assess coral reef resilience at over 220 survey stations across the region. Long-term quantitative data collected by Phuket Marine Biological Center and semi-quantitative method were also employed to assess and determine resilient reef areas both inside and outside Marine Protected Areas (MPAs). The results helped to identify the priority areas that need to be protected to enhance connectivity and ecosystem resiliency across Andaman Sea in Thailand. This paper suggests the key actions toward applying the same analysis including identifying critical habitats, assessing ecosystem resilience and using simple decision support making tool to develop MPA network in transboundary areas with Myanmar. In addition, this paper also recommends the potential governance platform in which such a transboundary conservation can be implemented through collaborative capacity building program, joint long-term monitoring program and marine spatial planning in Andaman bioregion.

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ENVIRONMENTAL AND BIOLOGICAL FACTORS ASSOCIATED WITH CORAL REEF RESILIENCE IN THE FLORIDA KEYS (Abstract ID: 29608)

Coral reef decline in the Florida Keys has been well-publicized, controversial, and polarizing. The Florida Keys have experienced unprecedented warming that has led to seven Keys-wide mass bleaching events since 1987. Not surprisingly, coral cover has plummeted to ≤ 5% on offshore reefs and continues to decline. An exception to this trend are the inshore patch reefs that are located between the islands of the Florida Keys and the offshore reefs. Coral cover on the patch reefs ranges from 15-35%, with some reefs having values > 40%. Coral extension and calcification rates are higher inshore and show marked resilience to both cold and warm-water stress. Although 2014 was the warmest year on record, mortality at Cheeca Rocks, an inshore study site, was low. This inshore-offshore dichotomy in reef health is enigmatic because inshore reefs experience greater thermal variability, increased turbidity, increased sedimentation, elevated nutrients, and are nearer to human populations versus those offshore. Our current research is taking advantage of the 2015 mass bleaching event to determine if this inshore resilience is a result of: 1) Thermal acclimatization/adaptation, 2) Higher turbidity/shading ameliorating bleaching impacts, 3) Increased heterotrophy, owing to turbidity, during bleaching and recovery, 4) Heat-tolerant algal symbionts, and/or, 5) Elevated nearshore pH. This talk will summarize our past and present research in the Florida Keys on climate change, ocean acidification, and the factors associated with the resistance and resilience to these impacts.

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WHAT MAKES TEMPERATE CORAL SO ROBUST IN AN ERA OF GLOBAL WARMING? A COMPARATIVE TRANSCRIPTOMIC STUDY BETWEEN SUB-TROPICAL AND TEMPERATE CORALS (Abstract ID: 27825)

Rapid increase in atmospheric CO2 drives global warming and ocean acidification and raises concerns regarding corals that are adapted to a narrow range of pH and temperature. We studied the effect of slow, chronic temperature increase integrated (over a period of 8 months) with low pH values, on a sub-tropical Red Sea coral, Stylophora pistillata, and on a temperate Mediterranean Sea coral Balanophyllia europaea. We utilized Ilumina Hiseq barcoding and further bioinformatic tools to generate and analyze the transcriptomes of S.pistillata and B. europaea. In S. pistillata an elevation of 2 degrees C above control was sufficient enough to change patterns of gene expression. In contrast, it required B. europaea > 9 degrees C to cluster apart from the control. Enrichment analysis showed that processes related to metabolism and energy were enriched in B. europaea at an early stage, yet in S. pistillata, protein degradation and cell death were apparent at the beginning of the experiment. The results imply that there is a synergistic effect between pH and temperature in terms of gene expression and algal photosynthesis yield. Here we demonstrate for the first time a differential gene expression pattern where the temperate coral, that in nature experiences annual temperature fluctuations two fold higher than sub-tropical coral, exhibited a more effective cellular coping mechanism when faced with temperature and pH stress. This strategy might involve diverting cellular resources into massive up-regulation of genes in general and in particular genes that are related to generation of cellular energy.

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GLOBAL AND LOCAL IMPACTS ON THE PHYSIOLOGY OF SYMBIONT-BEARING FORAMINIFERS, HYDROCORALS AND CORALS OF BRAZILIAN REEFS: A MESOCOSM APPROACH (Abstract ID: 29329)

Coral reefs are threatened by large-scale stressors (e.g., global warming and ocean acidification) and local impacts (e.g., nutrients and pollutants). We studied symbiont-bearing foraminifers (*Amphistegina gibbosa*), calcareous hydrozoans (*Millepora alcicornis*) and Brazilian endemic corals (*Mussismilia harttii*) exposed to increased temperature (+1 to +4.5°C), acidification (reduction of 0.3 to 0.9 pH units) and copper contamination (1.0 to 6.7 µg $L^{-1}$) of sea water, either isolated or in combination. Experiments lasted for up to 30 days in a mesocosm system. Biomarkers associated with oxidative status (total antioxidant capacity, lipid peroxidation, DNA damage), calcification (calcification rate, carbonic anhydrase and Ca,Mg-ATPase activity), and photosynthesis (Fv/Fm) indicated that acidification and exposure to dissolved copper affected the calcification process. Copper exposure also induced oxidative damage, suggesting an increased susceptibility to bleaching. The effects on calcification and bleaching were potentiated when both stressors were combined. Increasing sea water temperature affected calcification and photosynthesis. Combination of elevated temperature, acidification and copper contamination reduced photosynthesis and increased bleaching and mortality rates. Future scenarios of climate changes combined with local impacts can reduce the resiliency of coral reefs. Calcification and oxidative status biomarkers were adequate tools to assess reef organisms' health and can be effective tools in management strategies.

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CORAL SKELETAL LIGHT SCATTERING AND SUSCEPTIBILITY TO THERMAL BLEACHING (Abstract ID: 29452)

Differential coral bleaching has been attributed to a variety of factors and mechanisms; one recent focus has been on light collection capabilities. Multiple scattering of coral skeletons and tissues increase light availability to*Symbiodinium*, forming a very efficient biological collector of solar radiation. As photosynthetic performance of symbionts is often impaired during thermally-induced bleaching, light enhancement may promote a more severe bleaching response. Multiple lines of evidence indicate that light transport in the upper ~200 µm of the skeletal surface ('microscopic' reduced-scattering coefficient, $\mu_s'_m$ = inverse distance a short-path photon travels before randomization) affects light enhancement and bleaching response. Physical models of coral tissues indicate that $\mu_s'_m$ is predictive of the rate of light increase as symbiont densities decrease. The historical record of coral taxon-specific bleaching is correlated with $\mu_s'_m$. The rate and severity of experimentally-induced bleaching of 10 coral species is correlated with $\mu_s'_m$. And mathematical modelling using empirically determined parameters indicate that skeleton-derived light absorbed by symbionts, and its temporal rate of increase during

bleaching, are determined by $\mu_s'_{,m}$. Although the exact mechanism by which $\mu_s'_{,m}$ affects the bleaching response is not fully understood, it is becoming clear that skeletal optical scattering is an important determinant of differential bleaching.

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HIDDEN DIVERSITY OF CORAL REPRODUCTIVE AND GENOMIC TRAITS AND THEIR CONSEQUENCES FOR DIVERSIFICATION (Abstract ID: 30103)

To better understand coral evolution and speciation, it is useful to draw on theory and methods from the study of plants. This talk will cover three new findings from Curacao that expand our understanding of coral reproductive strategies and evolutionary mechanisms. First, we'll present evidence for marked differences in genome size between closely-related species in a low-diversity coral family (Meandrinidae). This observation supports the notion that non-ecological genetic mechanisms such as polyploidization or retroelement activity contributed to rapid diversification in this group. Second, we'll present evidence for self-fertilization in a subset of colonies of a broadcast-spawning coral species that is thought to be self-incompatible (*Colpophyllia natans*). This phenomenon could be due to germline mutations in individuals or chimerism in the population, with differing consequences for morphological and genetic diversity. Third, we'll discuss growing evidence for spermcast mating and internal fertilization in coral species that are currently classified as broadcast spawners (e.g., *Dendrogyra cylindrus*). Incorporating this often-overlooked intermediate mating strategy (neither broadcast spawning nor brooding) into models of coral trait evolution could advance our overall understanding of the process of speciation. Together these new observations help to illuminate the variety of mechanisms by which corals create genetic variation and the resulting paths along which coral diversification may proceed.

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RECONSTRUCTING CORAL COMMUNITIES THROUGH TIME TO DETERMINE THE EFFECT OF HUMAN INFLUENCE ON THE INSHORE GREAT BARRIER REEF (Abstract ID: 28414)

With human pressure in coastal regions rapidly increasing, chronic anthropogenic stressors are now regarded as an important catalyst in the global demise of coral reef systems. However, understanding the drivers of ecosystem change remains challenging, due to a lack of data preceding shifted ecological baselines. Inshore reefs are inherently vulnerable to the effects of intensifying development in coastal areas, suffering diversity loss, changes in habitat complexity and a reduction in the abundance of reef dwelling biota. Following European settlement (1780-1870) of the Queensland coast, the water quality within the Great Barrier Reef lagoon has declined. Heavily modified river catchments and large areas of land cleared have resulted in high sediment and nutrient-loaded runoff. Using reef matrix cores to extract fossil coral assemblages from the shallow reef slope environment of the Frankland Islands, we reconstruct coral community structure over the past 300 years. We established an ecological baseline of the relative abundance of coral taxa prior to European influence using a highly constrained temporal framework derived from U-series radiometric age dating. Inshore reefs were consistently dominated by hard coral but a substantial ecological change occurred over the past 50 years from a highly diverse to an almost mono-generic hard coral community. The shift in coral community structure occurred under an intensified disturbance regime since 1970 and highlights the importance of a historical perspective in understanding reef response to environmental change

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EXPANDING A LOCALLY MANAGED MARINE AREA NETWORK IN EASTERN INDONESIA: DRAWING FROM TRADITIONAL KNOWLEDGE AND MANAGING 'JEALOUSY' (Abstract ID: 29384)

Small-island communities in Eastern Indonesia widely apply traditional marine management methods. Responding to continuing coral degradation, these methods have been integrated with Locally Managed Marine Area (LMMA) approaches and are demonstrating success in developing locally effective regulations, strengthening local institutions, and restoring coral reef resources. The case study explores findings from the Upper and Lower Padaido Islands of Biak, Papua Province. Close collaboration between communities and the Indonesia Locally Managed Marine Area network (I-LMMA) has expanded the coverage of LMMAs from 9,000 hectares around a single island to 190,000 hectares over 21 island-communities. Communities are managing marine environments through village-level regulations that are officially recognized by the government. The growth of local management over a 5-year period is examined, with its expansion from establishment of LMMAs in individual villages to establishment of networks of LMMAs in numerous villages, islands and subdistricts. These networks are pursuing multiple management objectives over large areas including: long-term resilience, biodiversity conservation, ecosystem management, fisheries sustainability and climate change adaptation. Successful expansion hinged on the ability to (i) expand through existing customary networks, (ii) apply the latest marine science guidance in managed areas design (iii) apply effective and adaptive management strategies to address intercommunal 'jealousy', (iv) gain political support, and (v) develop trustworthy collaborations.
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CO-MANAGEMENT AND MARKET FORCES DRIVE SIZE OF FISHERIES LANDINGS (Abstract ID: 28659)

Co-management is typically based on agreements between governments and local communities to share the responsibility of resource management. The implementation of community-based co-management for fisheries has been going on in Mozambique since 2003. The first evaluation of the ecological effects of co-management, using the Cabo Delgado province as a case study, is presented here. The existing 78 fishing centers were classified according to their management situation, and the distance to the nearest town. Several diversity metrics were compared for each management level and some effects on community structure and diversity of reported landings detected, specifically in terms of species abundance distribution. The type of management affected the sizes of fish caught, with more active management leading to larger fish. Furthermore, the distance to markets had a strong effect on sizes, with more remote fishing centers having larger individuals, indicating that markets alongside management are a strong driver of the size of fishes caught by artisanal fisheries. Co-management in the north of Mozambique has a positive effect on maintaining larger sizes of fish caught, but markets are a powerful influence and with the predictable development of the region can potentially undermine co-management benefits.
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REALISING RESILIENCE: INTEGRATING ECOLOGICAL AND SOCIAL INFORMATION FOR ENLIGHTENED MANAGEMENT OF CORAL REEFS (Abstract ID: 28360)

We need to understand and manage coral reefs as linked social-ecological systems. Yet their complexity and dynamism, combined with our uncertainty about many aspects of their functioning and future, challenges both our governance arrangements and research efforts. Resilience theory has emerged as a framework for accommodating change and uncertainty, and for structuring decisions that incorporate the linkages between biodiversity and people. Operationalising resilience concepts has been an important focus of recent research at the science-policy interface, with valuable progress made in applying ecological resilience ideas. The crucial next goal is to develop frameworks, models and decision-support tools that explicitly connect biodiversity condition with social and economic benefits for coral reef management decisions. We note recent progress, highlight pitfalls and showcase early successes to provide a roadmap for taking social-ecological resilience from theory to operational reality in coral reef management.

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THE INTERACTION BETWEEN HERBIVORY AND ALGAL TURF DYNAMICS ON CORAL REEFS: INSIGHTS FROM A SIMULATION MODEL (Abstract ID: 29015)

Herbivory is an important process that helps to maintain the balance between corals and algae on coral reefs. Therefore, it is necessary to better understand the complicated interaction between herbivores and algal dynamics. Here, we investigate whether the field-observed algal turf standing crop biomass can be predicted based on local estimates of fish grazing and observed algal productivity rates. We used a spatially realistic model with daily rates of algal turf growth and fish herbivory in order to explicitly integrate short-term antagonisms in algal turf dynamics. The model was used to predict algal turf biomass in two contrasting reef crest environments (leeward vs windward),

on Heron Island, southern Great Barrier Reef. We tested hypotheses about the rates of grazing intensity and algal productivity in each habitat by comparing observed and modelled algal turf biomass. We further used the model to assess the relative importance of each process driving algal turf biomass on the reef, and the impact of different reef fish families and size classes in maintaining algal turf biomass. Finally, the model was used to simulate the impacts of different fishery-scenarios on algal turf dynamics; highlighting the model as a potential future tool for reef fisheries management. The model provides new insights, and challenges our understanding of the interaction between grazers and algal turf dynamics on coral reefs, enhancing our knowledge of the processes involved in these complicated relationships.
http://www.marinespatialecologylab.org/people/alyssa-marshell/

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THE WEST HAWAI'I CORAL RECRUITMENT PROJECT (Abstract ID: 28996 | Poster ID: 712)

Maintenance of adequate levels of coral recruitment is vital to sustain coral reefs. Because early life stages are often more susceptible than adults to environmental stressors, data on settlement and recruitment can help predict potential effects of disturbance from, and resilience to, environmental change. The spatial-temporal variability of scleractinian coral recruitment is currently being investigated along the west coast of Hawai'i. Starting in April 2004 to the present, terra cotta coral settlement tiles have been placed at ten sites spanning the leeward side of Hawai'i Island. Eight tiles at each of the nine sites are replaced biannually before and after known seasonal peaks in coral reproduction and recruitment. A new site Acropora Gardens, was added in August 2013, because of the discovery of a species of coral (Acropora gemmifera) never described in the main Hawaiian Islands. Distinctive characteristics in recruitment patterns underline the important role of life history strategies in understanding the spatial-temporal patterns of coral populations. The comparably low coral recruitment rates noted in this study indicate that recovery from natural and/or anthropogenic influences will likely be slow.

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A NEW GENUS FOR THE HAWAIIAN CORAL PARASITE PODOCOTYLOIDES STENOMETRA (DIGENEA: OPECOELIDAE) AND A COMPLEX OF NEW SPECIES FROM THE SOUTH PACIFIC (Abstract ID: 27976)

The only trematode known to parasitise corals, *Podocotyloides stenometra*, was first described from off Hawaii in 1966. Since then it has been reported from coral reefs elsewhere in the Indo-Pacific. The larvae of this trematode infect coral polyps, causing the disease *Porites* trematodiasis. The parasite matures in the intestine of corallivorous butterfly-fishes (family Chaetodontidae), which preferentially predate infected polyps. However, the type-species of *Podocotyloides* is known only from *Diagramma pictum*, a haemulid fish that does not feed on corals. We generated comparable sequence data for specimens of *P. stenometra* from Hawaii and a 'true' *Podocotyloides* species from a haemulid of the Great Barrier Reef and found them to be phylogenetically distant. We also generated sequences for specimens collected from chaetodontids of French Polynesian waters and found that *P. stenometra* actually represents a cryptic complex of at least six species. We characterise these new chaetodontid-infecting species and will propose a new genus to accommodate them and *P. stenometra*. The new data allow us to discuss patterns of biodiversity, evolutionary expansion, host-specificity and biogeography for species of the new genus and interpret the evolutionary significance of their unique life-cycles.

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GENE EXPRESSION DIFFERENCES IN CARIBBEAN CORALS IN RESPONSE TO NATURALLY ACIDIFIED SUBMARINE SPRINGS: RESULTS FROM A RECIPROCAL TRANSPLANT EXPERIMENT (Abstract ID: 30089 | Poster ID: 22)

Increasing amounts of atmospheric carbon dioxide are acidifying the ocean, causing negative impacts on coral survival and calcification. Previous studies have shown some coral species may be more capable of growing at low aragonite saturation levels than others. To test how corals may acclimate or adapt to low calcium carbonate saturation conditions, we developed a reciprocal transplant experiment at natural, low pH submarine springs in the Yucatán Peninsula (Mexico) next to the Mesoamerican Barrier Reef. Genetically identical nubbins of Siderastrea siderea and Porites astreoides collected in the springs, nearby in the lagoon (control site) and on the fore-reef were reciprocally transplanted into the low pH springs and into the control sites (away from the discharge and not impacted by low pH water). One year after transplantation, 45 corals were sampled and high-throughput RNA sequenced to analyze transcriptome differences. Preliminary analyses reveal significant changes in gene expression due to transplantation (i.e. acclimatization) as well as coral origin (i.e. adaptation). We will present in depth analyses of differential gene expression and gene function among the different locations and species, which may help to better understand the molecular mechanisms of acclimation and adaptation of corals to ocean acidification.

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PATTERNS OF CORAL BLEACHING IN THE MAIN HAWAIIAN ISLANDS DURING THE 2015 MASS CORAL BLEACHING EVENT (Abstract ID: 29678 | Poster ID: 357)

In 2015 there were several reports of bleaching across the Hawaiian Archipelago. The Office of National Marine Sanctuaries partnered with the University of Hawai'i Sea Grant College Program and the Hawai'i Department of Aquatic Resources to conduct coral bleaching surveys at the islands of Lāna'i, Maui, and Hawai'i Island aboard a NOAA research vessel. Data was collected using 1 m x 10 m belt transect methodology with an emphasis on coral demographics and bleaching extent and severity. Here we explore trends and patterns of observed coral bleaching across taxa and examine these trends across coral size, morphology, and spatial scales. This survey contains some of the only data at fine scale for coral reefs at Lanai Island and the Kohala area on Hawai'i Island from this 2015 coral bleaching event. Future efforts are needed to monitor the recovery of these integral coral reefs.

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IMPACT OF THERMAL STRESS ON GROWTH AND PHOTOSYNTHESIS IN LARVAE AND ADULT STAGES OF PORITES ASTREOIDES (Abstract ID: 27972 | Poster ID: 347)

Coral reefs face a number of environmental changes, chief among them rising temperatures, with consequences that are not entirely understood. A rise in sea surface temperature can affect physiological processes in different ways during each development stage, leading to higher or lower growth rates, or decreased survivorship. Here we determine the impact of thermal stress on photosynthesis and growth in P. astreoides at different developmental stages. Photosynthetic efficiency (Fv/Fm) of adults and larvae were measured using a Diving PAM (Walz). Growth rates of adults were measured using the buoyant weight technique and larval growth rates (planar area) were measured using light microscopy and Image J-Fiji software. The preliminary data for both stages show high values of effective quantum yield (Fv/Fm) when exposed to a temperature of 30°C, which may suggest an ability to acclimate to higher temperatures. With an exposure time of five days however, there was a reduction in effective quantum yield, indicating that in the long term this may be a stressful condition for corals. We see similar responses in growth rates at 30°C for adult and larvae stages. This suggests that P. astreoides is relatively tolerant to high temperatures but that they are dependent on diurnal temperature decreases to avoid a build-up of damage to the photosynthetic machinery.

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DIFFERENTIAL REEF FISH RECOVERY IN SELECTED MARINE PROTECTED AREAS IN THE PHILIPPINES AFTER SUPPLEMENTAL MANAGEMENT INTERVENTION (Abstract ID: 28622)

Establishing marine protected areas (MPAs) is a common management intervention utilized to allow for the recovery of fish stocks. To supplement this strategy, RARE Philippines have conducted pride campaigns in selected MPAs in the country. This is a social marketing strategy that aims to elicit community involvement in conservation and enforcement of MPAS. We monitored the performance of selected MPAs prior to and 2-3 years after the introduction of the pride campaigns. Fish visual census was done on transects both inside and outside the MPAs. Despite all having good pride campaigns, the sites showed variable rates of change in fish species richness, abundance, and biomass across a series of monitoring surveys. This may be attributed to differences in the initial standing stock. In some sites the fish communities improved and then became stable, suggesting that the community may have reached a ceiling that is unique to the

site. We also observed changes in the composition of specific trophic groups which warrants further investigation.

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SEXUAL REPRODUCTION OF THE ENDANGERED AND ENDEMIC CORAL PORITES SVERDRUPI AND ITS RELATIONSHIP WITH ENVIRONMENTAL FACTORS (Abstract ID: 28530)

Corals around the world are facing threats at both local and global scales. In order to understand how species will face such threats it is necessary to understand the basic biology of these organisms. Sexual reproduction is a determinant process in the life of scleractinians since it ensures the continuity of lineages and increases populations' resilience through genotype diversification. Moreover, the study of coral reproduction is essential to develop successful strategies for coral restoration and conservation. This study is part of Porites sverdrupi's recovery program, an endemic species of the Gulf of California considered a "Vulnerable" species in the IUCN's Red List whose range of distribution has decreased in recent decades probably due to the effects of global change. The purpose of the study was to document P. sverdrupi's gonadal cycle and to relate it with oceanographic variables. This coral is a gonochoric brooding species that produces planuale from June to August, although female gametes can be found throughout the year while male gametes appear from March to October. Planulae were found at temperatures from 29 to 32 °C and at photosynthetically active radiation (PAR) levels above 50 Einstein/m2/day; while mature gametes were found at temperatures above 25 °C and similar PAR levels. The study was partially carried out during a strong ENSO event (2015), which may cause results to not be typical under normal conditions.

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BIOGEOCHEMICAL PATTERNS OBSERVED BY AUTONOMOUS SENSORS ON THE REEF TERRACE AT PALMYRA ATOLL (Abstract ID: 29125)

For the past six years we have operated a variety of autonomous sensors at coral reefs in the tropical Pacific Ocean, most frequently at Palmyra Atoll. This presentation will provide an overview of the different technologies used at Palmyra, focusing in particular on a five month dataset of pH, pCO2, oxygen, salinity and temperature on the reef terrace. The hourly observations of reef biogeochemistry reveal the dynamics of the environment experienced by organisms living in this sensitive habitat. In this study we characterize the natural variability in the CO2 system on time scales from hourly to seasonal and discuss the physical vs. biological drivers that give rise to the cycles captured by the sensors. In addition, we examine the relationships between biogeochemical variables including dissolved inorganic carbon, and oxygen, and physical variables including temperature, salinity, density and tidal stage.
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CORAL TAKEOVER BY THE ENCRUSTING EXCAVATING CARIBBEAN SPONGE CLIONA TENUIS HAS REACHED A STANDSTILL IN COLOMBIAN CORAL REEFS (Abstract ID: 29785 | Poster ID: 245)

On Caribbean reefs, the excavating sponge *Cliona tenuis* colonized the dead skeletons of the elkhorn coral *Acropora palmata* after its massive die-off in the 1980s. Further coral death occurred through *C. tenuis* lateral growth. To follow up a previous 2001 characterization at Islas del Rosario (Colombia), abundance and size structure of *C. tenuis* were again measured in 2014, along with its substratum preference. The fate of sponge individuals colonizing massive coral colonies marked in 2001-2004 was also followed. Although *C. tenuis* is still disproportionally occupying dead *A. palmata branches*, its abundance and density and the cover of other benthic elements did not significantly changed over the 13-year period, indicating that a standstill had been reached. *Cliona tenuis* was thus initially favored, but substratum monopolization did not occur. Small individuals increased in number and very large ones decreased, indicating that, in addition to new recruitment, larger sponges are fragmented as the *A. palmata* branches where they dwell continually collapse. Marked sponges killed corals over the first few years, but over longer times they retreated or died, and corals were able to resume growth. However, it could not be ascertained whether the sponge retreat was age-related or the result of some environmental effect. The apparent preference for recently dead clean coral by larvae of *C. tenuis* and its current dynamics of recruitment, growth, fragmentation and mortality have stabilized its space occupation at Islas del Rosario.

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A BASIC STUDY ON BENDING FRACTURE BEHAVIOR OF *ACROPORA INTERMEDIA* (Abstract ID: 27819 | Poster ID: 236)

It is known that formation of skeleton in branching coral is affected by environmental factors. However, bending strength property of the skeleton in branching coral is not really investigated in the field of biological engineering. In this study, we investigated bending property of *Acropora intermedia* which were kept in Okinawa Churaumi Aquarium from the point of view of mechanical engineering. We conducted 4-point bending test based on "JIS R 1601 standard" which was "Testing method for flexural strength (modulus of rupture) of fine ceramics at room temperature" of Japan Industrial Standard. And we observed internal structure of the skeleton by using the X-ray Computed Tomography technique. The results show the following: (1) The root portion of skeleton show a high bending strength because the density of skeleton is higher than the that of tip portion. (2) The surface side of colony show higher bending strength than the inner side because the porosity density is low.

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TEMPORAL EXPRESSION PATTERN OF BIOMINERALIZATION PROTEINS DURING EARLY DEVELOPMENT IN THE STONY CORAL POCILLOPORA DAMICORNIS (Abstract ID: 27829)

Reef-building corals begin as non-calcifying larvae that, upon settling, rapidly begin to accrete skeleton and a protein rich skeletal organic matrix (SOM) that attaches them to the reef. Here, we characterized the temporal expression of a suite of biomineralization genes during three stages of larval development in the reef-building coral Pocillopora damicornis: Stage I - newly released, Stage II - oral-aborally compressed, and Stage III - settled and calcifying spat. The transcriptome analysis revealed 3,882 differentially expressed genes that clustered into distinct patterns across the three developmental stages. Among these, we identified 74 novel acidic proteins (CARPs) that are highly conserved across calcifying cnidarians, but lack detectable homologs in non-calcifying taxa. Immunolocalization supports the direct role of several CARPs in calcification. Our results reveal, for the first time, the developmental sequence that leads to formation of the organic scaffold of corals and the initiation of aragonite precipitation in a stony coral.

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INTER- AND INTRA- SPECIFIC VARIATION IN HAWAIIAN CORALS RESPONSE TO ELEVATED SEA SURFACE TEMPERATURES (Abstract ID: 29908 | Poster ID: 359)

Coral bleaching is a natural phenomenon that occurs as a result of increased sea temperatures and solar irradiance. Global climate change has increased the frequency of warm ocean temperatures and bleaching events which often follow such conditions. Unprecedented bleaching events occurred in the Main and Northwestern Hawaiian Islands during the Fall of 2014 and 2015. Hawaiian corals reacted variably with differing levels of recovery and/or mortality spanning across locations and taxa. This project aimed to document the extent of the events in an attempt to understand the variation in bleaching susceptibility for the reefs at Ka'ohao (Lanikai), Oahu. In situ data loggers were used to record seawater temperature from July 2014-December 2015; highest recorded temperatures were 30.8 C and 31.1 C in 2014 and 2015, respectively. Health of 80 individual coral colonies of Porites, Montipora, and Pocillopora was assessed weekly. Mixed effects models were used to compare bleaching and recovery metrics between species, within species, between dates, and the interactions between these factors. Video transects were conducted every other month from September 2014-December 2015 to assess the extent of bleaching by species. Mean percent bleaching (± SE) for all species in September and October, the two warmest months, was 21.0% (± 2.20) and 30.3% (± 2.25) in 2014 and 2015 respectively. Through multiple monitoring methods and this project revealed complex response and recovery patterns of Hawaiian corals to these unprecedented bleaching events.

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SUCCESSFUL CORAL RESTORATION VIA FRAGMENT TRANSPLANTATION IN GULF OF MANNAR, INDIA (Abstract ID: 28535 | Poster ID: 488)

The reefs of Gulf of Mannar degraded extensively during the period between 1960 and 2000 due to rampant mining and other destructive activities. To regain the coral cover in the degraded area, coral transplantation (low tech method) was initiated in the Vaan Island during 2004. The fragments of eight native coral species were transplanted on concrete frames (1m X 1m) in approximately 30 m2 area. Transplanted corals were monitored regularly to document survival and growth between 2004 and 2010. 73.26% of the transplanted fragments survived until 2010. Acropora intermedia had the highest average growth with 11.75 cm/year. Coral cover, diversity and recruitment on restored and adjacent natural reef were monitored between 2005 and 2014. Coral cover increased from 30 to 850 m2 in the restored site and significant increase of live coral cover was noted from 5.82±4.38% to 47.37±9.75% between 2005 and 2014. Whereas in the nearby natural reef, an increase in the live coral cover from 7.82±3.85 to 18.23±1.97% was observed. Natural coral recruitment was higher in the restored reef than in the natural reef. Fish abundance increased from 22 to 450 individuals/100 m2 and the reef associates like coralline algae and mollusks were also common in the restored sites. The increase of coral cover in the restored site can be attributed to the successful sexual and asexual reproduction of the transplanted coral colonies. The decadal observation revealed that transplantation with native coral fragments especially with Acropora and Montipora species has been successful in Gulf of Mannar.

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TROPICAL FISH ABUNDANCE IS PREDICTED BY HABITAT ACROSS A TROPICAL TO TEMPERATE GRADIENT (Abstract ID: 28964 | Poster ID: 363)

Ocean warming is driving rapid poleward expansion of tropical marine organisms, particularly in areas surrounding poleward flowing ocean currents. Each summer the East Australian Current transports fish larvae from tropical latitudes to temperate coastal and offshore locations. Many coral reef fish larvae rely directly on live corals for settlement and the availability of preferred corals can dictate survival and performance of these fishes. Benthic reef communities differ markedly between tropical, subtropical and temperate latitudes, yet it's unclear how changes in availability of preferred habitats influence distribution, abundance and fitness of tropical fishes. We quantified abundance and composition of reef fishes and benthic assemblages across 17 degrees of latitude on the east coast of Australia, from the northern Great Barrier Reef to Sydney. We present trends on the relationships between habitat type and structural complexity with abundance and diversity of reef fish communities. Species correlated with areas of high coral cover did not extend beyond the Solitary Islands. Conversely, tropical species with more generalist habitat associations did extend to Sydney. These results contribute to understanding range expansion and how tropical reef fishes may utilize refugia at higher latitudes. With global degradation of coral reefs, declines in coral cover and range expansion of tropical fishes, more detailed studies are needed to gain greater insight into implications of range expansion and tropicalisation of temperate reefs.

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USING COMPLIMENTARY SAMPLING METHODS TO ADDRESS SIMILAR QUESTIONS: RESOURCE AND HABITAT USE OF SYMPATRIC CORAL TROUT (Abstract ID: 28431)

Understanding the ecological role and associated behaviours of aquatic animals is often difficult because sampling techniques have inherent limitations. The goal of this study was to explore how different sampling approaches (passive acoustic telemetry and dietary proxies) can be used in conjunction to provide a more refined account of fish behaviour. Fifty-eight acoustic receivers were deployed at three reefs to monitor the movements of an economically significant species group – coral trout (*Plectropomus* spp.; n=156 individuals). Additionally, gut content identification (visual and DNA) and stable isotope analysis were completed over a two year period to assess spatial and temporal changes in foraging patterns. By using multiple approaches, we found that broad resource and habitat selection trends differ between sympatric species, but interestingly, the way they differ is unique to each species pairing. For example, at offshore reefs the space use of *P. laevis* overlapped with *P. leopardus*, and they consumed distinct prey; while at inshore reefs, the space use of *P. maculatus* had little overlap with P. leopardus, and they consumed similar prey. This research highlights the need for species-specific management initiatives since *Plectropomus* spp. are often treated as a single stock in the Great Barrier Reef fishery. Further, these findings demonstrate the value of using complimentary sampling approaches to address research questions.

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PHYLOGENETIC AND MORPHOLOGICAL ANALYSES REVEAL CRYPTIC SPECIES COMPLEXES IN GLOSSODORIS NUDIBRANCHS (Abstract ID: 28824)

Chromodorid nudibranchs (Opisthobranchia: Nudibranchia) are tropical sea slugs that live in biodiverse and threatened coral reefs and act as early indicators of climate change and reef health. The evolutionary relationships within this family have not been well understood, especially in the genus*Glossodoris*, which has sustained over 100 taxonomic changes in part due to morphological characters being the sole traditional taxonomic identifiers. Advances in molecular systematics have led to a rapid increase in the discovery of cryptic species - species that are classified under the same name, but differ genetically and oftentimes morphologically - in organisms exhibiting diverse and complex coloration with complicated taxonomic histories. *Glossodoris* nudibranchs exhibit a wide range of color patterns from aposematic coloration to camouflage, and are a model group for understanding cryptic diversity. In this study, 80 individuals comprising 38 species were used to build the most robust phylogenetic tree of *Glossodoris*and related genera using mitochondrial genes COI and 16S, and nuclear 28S. Maximum likelihood, Bayesian inference, and Parsimony statistical analyses verified recent taxonomic reclassifications among genera in the Chromodoridae with minor revisions, and identified two cryptic species complexes within *Glossodoris* and three new species of *Doriprismatica*, which were confirmed through specimen dissections and SEM micrographs. Species within the cryptic complexes presented biogeographic and morphological differences. http://gatescorallab.com/shayle-matsuda

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PHOTO-PHYSIOLOGY OF IN HOSPITE ZOOXANTHELLAE IN DISEASED AND HEALTHY SCLERACTINIAN CORALS FROM MAURITIUS (Abstract ID: 29620)

The recent increased incidence of coral diseases due to ocean warming is threatening the health of coral reefs. Diseases in reef-building corals are likely to modify the holobiont micro-environment which has a direct impact on the photosynthetic potential of the symbiont. This study investigates the occurrence of coral diseases, namely tissue sloughing (white band disease, WBD) and complete whitening (white plague, WP), among scleractinian corals in the tropical lagoon of Belle Mare Mauritius, and also characterises the photosynthetic responses of *in hospite* zooxanthellae in diseased and healthy corals using an underwater Pulse-Amplitude Modulated Fluorometer. The coral disease occurrence survey (n=20 colonies) and sampling for diseased/ healthy corals were carried out at nine stations along three transects across the lagoon from coast to reef over the summer months of 2013 - 2015. A high percentage (90%) of disease occurrence was observed in the branching *Acropora muricata*, both WBD (45%) and WP (55%), as compared to *Pocillopora damicornis* (10%) with WBD only, *P. eydouxi* (0%), *Galaxea fascicularis* (0%), *A. cytherea* (0%) and *Fungia repanda*(0%). Maximum quantum yield (Fv/Fm) was normal (0.6±0.008) in all healthy corals, but was very low (<0.2) in diseased corals indicating damage to the photosynthetic apparatus. *A. muricata* was the most common host and most susceptible among the corals studied, thus having implications for coral reef management and conservation in the face of a climate-driven ocean warming.

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PARTNER SWITCHING AND NUTRITIONAL INTERACTIONS IN A MODEL CORAL-DINOFLAGELLATE SYMBIOSIS: THE APPLICATION OF COMBINED TRANSCRIPTOMIC AND METABOLOMIC ANALYSES (Abstract ID: 28399)

Coral bleaching potentially provides an opportunity for corals to form novel symbioses with algae better suited to the prevailing environment, which could allow for the future

survival of reefs. However their potential success is dependent on functional and sufficient nutritional exchange. Here, we present a novel approach combining gene expression with metabolite profiles to investigate the nutritional potential of various symbiont types when in symbiosis with the model anemone Aiptasia sp. Transcriptomic and metabolomic analyses were carried out, respectively, with next-generation RNA sequencing and gas chromatography mass spectrometry on aposymbiotic Aiptasia, and Aiptasia experimentally infected with either the homologous Symbiodinium type B1 or a thermally tolerant type D1a. Symbiosis establishment was more successful with type B1 (>300%) than type D1a. Correspondingly, our analysis revealed differential expression of metabolic pathways according to symbiotic state (Apo/B1/D1a), allowing us to generate testable hypotheses about the nutritional implications of symbiotic state. We will present a comprehensive gene-to-metabolite perspective of the nutritional significance of partner switching and potential for adaptation to climate change. Integrating transcriptomics and metabolomics as reported here will facilitate more powerful studies of coral physiology and the effects of biotic/abiotic stress on the coral-algal mutualism. A better understanding of these molecular mechanisms will contribute to the development of strategies to promote post-bleaching recovery of corals.

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RECONSTRUCTING AND FORECASTING OUTBREAKS OF CROWN-OF-THORNS STARFISH ON THE GREAT BARRIER REEF: SPECIES DISTRIBUTION AND POPULATION MODELLING APPROACHES (Abstract ID: 28267 | Poster ID: 212)

Outbreaks of the coral eating crown-of-thorns starfish (CoTS), Acanthaster planci, have contributed greatly to sustained declines in live coral cover on the Great Barrier Reef (GBR), accounting for 48% of coral loss over the past 30 years. Unlike other disturbances (e.g., cyclones and coral bleaching), CoTS outbreaks may be amenable to direct management, especially if reef-wide outbreaks originate in small, well-defined areas. This study reconstructs reef-wide outbreaks using extensive empirical data on population structure and distribution, to help establish when, where and why outbreaks originate. We define habitat suitability for CoTS using an ensemble Species Distribution Modelling approach coupled with larval connectivity estimates across the GBR, allowing us to identify the probabilistic pathway of the southward propagation of CoTS outbreaks. Higher proportions of suitable habitat and high between-reef connectivity were found in the northern GBR, supporting the hypothesis that this area acts as an "initiation zone" for reef-wide outbreaks. These results will be coupled with a stage-based, spatially explicit meta-population model, allowing us to simulate the initiation and propagation of CoTS outbreaks under a range of management strategies. Our model will provide invaluable predictions for decision makers, identifying the key locations for control measures to help prevent the spread of future outbreaks. These predictions are an integral step towards reducing coral loss caused by CoTS outbreaks, and hence protecting live coral cover on the GBR.

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USING GENOMICS TO RECONSTRUCT CORAL POPULATION SIZES OVER THE PAST 100,000 YEARS (Abstract ID: 29553)

One way to understand how corals will react to climate change in the future is to examine how they were affected by similar changes in the past. We have used 2bRAD to generate extensive genome-wide single nucleotide polymorphism (SNP) datasets for Acropora millepora in the Great Barrier Reef and two coral species in Florida Keys, Siderastrea siderea and Montastrea cavernosa, and applied dadi and PopSizeABC methods to reconstruct past population sizes. To scale the results in calendar years we experimentally determined the per-generation mutation rate for Acropora millepora, based on the frequency of novel mutations in larval offspring compared to parents. We detect dramatic changes in coral population associated with the last glacial maximum. Perhaps surprisingly, in the Great Barrier Reef A. millepora appears to have been in decline since the onset of last deglaciation. We hypothesize that these changes are predominantly driven by sea level variation.

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MAKAI WATCH: BUILDING A BRIDGE FOR GOVERNMENT ENGAGEMENT WITH COMMUNITY STEWARDS (Abstract ID: 29895 | Poster ID: 563)

In Hawaii, gaps in resources enforcement capacity has prompted the Department of Land and Natural Resources, coastal communities, and NGOs to work together creating a community-based marine resource stewardship program called Makai Watch (MW), with support from NOAA Coral Program. Now more than 10 years evolved, Makai Watch volunteer programs conduct outreach activities and participate in annual awareness raising and observation incident report trainings, providing trained "eyes on the reef" and reports to Div of Enforcement (DOCARE) on illegal marine resources related activities. The state formalized the Makai Watch Strategy (2014), program standards and operating guidelines as an official State program of DLNR- DOCARE. It currently engages officially with 8 communities throughout the state, and less formally with an additional 15. MW communities are estimated to engage with 200,000 beachgoers yearly. With a year into implementation, the program has provided many beneficial lessons learned from the planning and implementation phases to more recent evaluations of the program. Lessons include cross-agency communication and collaboration, increased community engagement opportunities with DOCARE officers, as well as national and international spotlight from communities looking to steward their coastal areas in relationship with resource managers and resources enforcement officers, including in the Caribbean region after a successful cross-basin learning exchange. Next steps include creating Memorandum of Agreements with MW communities and the DLNR-DOCARE.
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TOXICOLOGY OF EXPLOSIVE COMPOUNDS TO CORALS (Abstract ID: 29983 | Poster ID: 457)

Military activities in marine environments (i.e., training and demilitarization) have resulted in munitions and unexploded ordnance being located throughout the world's oceans, yet the ecological impacts to marine life from the associated chemical constituents and their breakdown products remains largely unknown. Coral reefs are particularly vulnerable ecosystems found in proximity to many key U.S. military installations in the Caribbean and Pacific Islands. We investigated whether munitions compounds or their breakdown products impact coral and coral health by conducting standard laboratory toxicity testing of nine munitions compounds (TNT, 2,4-DNT, 2,6-DNT, 2,3-DNT, 4-NT, 2-ADNT, RDX, HMX and picric acid) with Pocillopora damicornis coral. NOEC and LOEC values and effect-concentration (LC or EC) values were established using a coral cell toxicity assay. Findings showed all nine munitions compounds had some level of toxicity, differences in coral species' sensitivity to munitions compounds, and photo-enhanced toxicity of certain compounds. The toxicity reference values for corals exposed to munitions compounds will provide metrics for assessing risk of munitions to coral and coral reef health and serve as a basis for establishing screening and action values for management of this vulnerable resource.
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PLASTICITY OF HERBIVOROUS FISH FUNCTION IN RESPONSE TO FISHERIES AND WATER QUALITY IN FIJI (Abstract ID: 28601)

Human impacts can interact with ecosystem functions in complex ways, investigation of which necessitates multivariate perspectives. Using underwater visual census and remote cameras, this study identified functionally important herbivorous fishes based on behavioural feeding traits and quantified trait plasticity across different levels of water quality and fishing effort in Fiji. Catch surveys and interviews with fishermen elucidated consistent morphological and aesthetic traits responsible for a fishes' vulnerability to coral reef fisheries throughout the archipelago. Feeding observations illuminated functional plasticity driven by the nature and magnitude of anthropogenic influence where reefs with poor water quality and highest fishing effort exhibited functional niches not occupied by resident herbivore assemblages. Comparing data sets compiled from camera footage and catch surveys provided a novel insight on the impact of fishing and other anthropogenic influences to herbivorous function in the region. Functionally important fishes observed on more pristine reefs were virtually absent from reefs near more heavily fished areas, while some ubiquitous fishes surprisingly occupied narrower functional niches on impacted reefs. High sediment input is likely responsible for niche compression in such areas. The synergy of poor water quality and inshore fisheries' selectivity for key herbivores could lead to undermined reef resilience near densely populated areas.

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IN OR OUT: DOES THE EXPANSION OF CORAL POLYPS EXPLAIN HETEROTROPHY VS. AUTOTROPHY IN CARIBBEAN GORGONIANS? (Abstract ID: 28447)

Gorgonian corals (Octocorallia) dominate Caribbean coral reefs, yet knowledge about their metabolic intake is sparse. With suspension feeding they capture a variety of nutri-

ent sources from dissolved organic matter to plankton. They can also obtain products translocated from their endosymbionts, *Symbiodinium* spp. We evaluated heterotrophy vs. autotrophy to the metabolic needs of 6 shallow gorgonian species belonging to the families Plexauridae, Gorgoniidae and Anthothelidae. In the Mexican Yucatan Peninsula, we observed gorgonian polyp activity, polyps contracted or extended, and whether the tentacles were expanded in the extended polyps, over 24 hours. Polyp activity may impact feeding and the light environment thus affecting the *Symbiodinium*. Polyp activity did not correlate with taxonomy. One species expanded its polyps with extended tentacles for all 24 hours, 3 species expanded polyps and tentacles during the day but retracted them at night, and 2 species expanded polyps during the day but not their tentacles, retracting their polyps during the evening. Increased tentacle activity correlated with gorgonians having high lipid and protein content, while species with the least amount of polyp activity had the lowest lipid and protein content. Analyses of $C^{13}$ and $N^{15}$ stable isotopes is ongoing. Understanding gorgonian coral reliance on heterotrophy or autotrophy will aid in deciphering why in the Caribbean gorgonian corals better withstand changing environmental conditions than many scleractinian corals.

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MULTI-CRITERIA ESTIMATES OF CORAL REEF FISHERY SUSTAINABILITY (Abstract ID: 28002)

A holistic and scientific basis for achieving ecosystem-based management is needed to counter the continuing degradation of coral reefs. A holistic basis for sustainability is developed that includes information on reported and modeled yields, biomass and ecosystem thresholds, biomass recovery rates, and changes in yield over time. The coral reef fisheries literature reports high variability but this aligns well with high variation reported for biomass recovery and associated logistic model yield predictions. Recovery rate variability can, however, be attributed to a number of factors other than variation in endogenous production, including poor compliance and movement of fish into closures. Nevertheless, high harvest rate variation is more likely due to both temporary and long term harvesting beyond sustainable levels. For a conservative stock of 0.50 pristine biomass (~50 tons/km2), the most controlled recovery studies predicted mean yields of 7 tons/km2/y but high variability ranging from 2 to 13 tons/km2/y. There are few studies of reef fisheries yields over time but Kenyan fisheries studied for >10 years indicate that yields of > 6.9 tons/km2/y were not sustainable. Fish production at low biomass can increase and offset predicted declines in yields but biomass studies in Kenya found a small increase that would be insufficient to avoid declining yields. Ecological change occurs prior to the logistic model's maximum yield predictions, with 3 of 8 abrupt changes occurring before MSY. Knowing fishable biomass is important when predicting sustainable yields and a variety of metrics suggest that it should be maintained above 50 tons/km2 to avoid unsustainable yields.
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STRONG SPATIAL SIGNAL OF CORAL LOSS DETECTED FROM 240 YEAR-OLD NAUTICAL CHARTS (Abstract ID: 28008)

Large declines in the cover of live coral have been documented across the Caribbean over the scale of decades. However, analyses based on recent data alone may may miss larger scale changes that took place before modern observations (i.e. the loss of whole reefs). Therefore, creating temporally extended spatially-specific baselines based on historical data is important to quantify the full extent of long-term change. Early nautical charts provide one solution to the issue of lacking spatial data over long time scales; high-resolution nautical charts produced as part of European colonial expansion frequently contain high quality ecological information that can be used to reconstruct spatial change, but remain an underutilized source of information in quantifying long-term ecological change. Here, we use 18th century British nautical charts to quantify spatial changes and overall loss of coral reef habitat in the Florida Keys over 240 years. We find a strong spatial dimension to this decline; coral in Florida Bay and near shore declined substantially, while offshore coral remained largely intact. The near complete elimination of near-shore coral represents an under-appreciated spatial component of the shifting baseline syndrome, with important lessons for other species and ecosystems. In particular, assessments of change focusing only on species' extant range may overlook larger-scale loss over longer time frames and provide overly optimistic views of their current conservation status and underestimate restoration potential.

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A MODERN FISH TOOTH REFERENCE COLLECTION TO HELP TRACK HISTORICAL CHANGE IN CARIBBEAN REEF FISH COMMUNITIES FROM TOOTH FOSSILS FOUND IN REEF SEDIMENTS (Abstract ID: 29948 | Poster ID: 4)

Centuries of overfishing along with more recent habitat degradation have altered Caribbean reef fish communities and caused a loss of 50-80% of corals since the 1980s. The lack of an ecological baseline for Caribbean reef ecosystems, including data on reef fish abundance and composition, prevents an understanding of the full extent and causes of the recent Caribbean reef collapse. Fossil records of fish teeth are abundant in reef sediments and can provide a quantitative reconstruction of changes in reef fish communities over periods of both low and high human impact. To track changes in reef fish assemblages and demonstrate the variety of tooth morphotypes found within the ichthyolith record, we have constructed the first fish tooth reference collection for modern Caribbean reef fishes. From 375 specimens amassed from museum collections in the US and fish markets and field collections in Panama, totaling 81 unique families and 256 unique species, we developed a photographic reference collection via dissection and photography of oral and pharyngeal jaws and teeth. The collection, available at http://ichthyolith.ucsd.edu/, highlights the noticeably small tooth sizes of almost all species regardless of body size and diet. This collection has been utilized to classify abundant fossil teeth from reef matrix cores from Caribbean Panama to family level, enabling us to track changes in ecologically important groups such as parrotfish from the prehistorical period to the present.

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OPERATIONALISING THE PRECAUTIONARY PRINCIPLE FOR DEALING WITH UNCERTAINTY: THE EFFECTS OF DREDGING ON THE GREAT BARRIER REEF AS A CASE STUDY (Abstract ID: 29920)

Management agencies and policy-makers must make decisions and take action in the face of uncertain and often controversial knowledge, as illustrated by public debate about the effects of dredging on the Great Barrier Reef (GBR). Although the Precautionary Principle is often advocated for such situations, for government agencies it risks being operationally/politically infeasible, amounting to a "disallow everything" until all scientific questions have been definitively answered; this may take decades. Taking an innovative approach to dredging impacts on the GBR, we assembled a panel with a broad range of expertise and perspectives. We then developed an independent, balanced compilation of the full range of expert views. Rather than aiming for a single, definitive "consensus" view on all matters, we took a more pragmatic approach of identifying areas of i. agreed knowledge, ii. agreed knowledge gaps, and ii. areas where the experts don't agree. This allows progress, instead of getting caught in contention and controversy. In this case, many but not all of the experts consider that dredging effects have probably been historically under-estimated. Their main concern was the long-term contributions to fine sediments and turbidity, by ongoing resuspension of dredge material, especially at disposal sites. The direct effects of excavation and burial are severe but have a limited footprint. Our approach provided a timely scientific foundation (of knowledge and uncertainty), contributing to a major shift in policy including banning marine disposal of sediments from capital dredging.

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SOUNDS LIKE TROUBLE: ANTHROPOGENIC SOUND IMPACTS REEF FISH DYNAMICS (Abstract ID: 27818)

Anthropogenic noise may have detrimental effects on the ecology, physiology and behaviour of organisms, but the impacts of noise pollution on survivorship are not clear. We use juvenile coral reef fishes to examine the impact of outboard motorboat noise on predator-prey interactions. Our previous studies have shown that boat noise from 2-stroke 30hp engines affect survival of juveniles through physiological stress and a diminished startle response, leading to higher levels of predation. Here we show using a field experiment that real boat noise alone does not have a detrimental effect on fish to alter their survival. Boat noise did alter the way fish use the cues that indicate predation risk. Laboratory exposure to boat noise playback prevented juvenile damselfish from learning the identity of 3 common predators, such that they died 3x faster in the field compared to fish who learnt predator identity under ambient reef sound. Field experiments also showed that the behaviour of juveniles exposed to continuous real boat noise returned to a pre-exposure state after 20min. This may be due to damage of the acoustic sensory apparatus or habituation. While juvenile damselfish may have the ability to habituate to noise the detrimental short-term effects of boat noise through distraction

and physiological stress appear to dramatically influence mortality levels. This suggests boat noise has the potential to markedly alter population replenishment and community dynamics in busy waterways.

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ESTIMATING NEARSHORE FISHERIES CATCH FOR THE MAIN HAWAIIAN ISLANDS (Abstract ID: 28770)

Nearshore fisheries in the main Hawaiian Islands (MHI) have great economic, recreational, and cultural value. Currently, information on these fisheries is disparate and incomplete, creating a challenge for effective management. This study combines and synthesizes several commercial and small-scale non-commercial datasets to estimate the total catch of nearshore fisheries in the MHI. Data used came from catch reports submitted by commercial fishers, a statewide recreational fisheries survey, and 12 small-scale, non-commercial creel surveys conducted at sites in Kauai, Oahu, Lanai, Maui, and Hawaii. Results include an estimated range for total nearshore catch between 1,441,407 and 7,739,548 kg/yr., with the non-commercial catch between 9 and 53 times the reported commercial reef fish catch. Additionally this study provides a comprehensive overview of the MHI nearshore fishery, including best-available estimates of fishery data such as catch-per-unit-effort (CPUE), gear-preference and participation rates, with data broken out at island-scale. This is likely more appropriate for management purposes than the statewide level at which nearshore catch data is currently reported in the MHI.

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HOW CORALS CONTROL CALCIFICATION IN A HIGH $CO_2$ WORLD (Abstract ID: 28616)

Scleractinian corals have been spectacularly successful in building the calcium carbonate coral-reef edifices that harbour a significant part of the oceans biodiversity. Their success can largely be attributed to their ability to biologically mediate the composition of their calcifying-fluid and thereby increase the carbonate saturation state (Ω) to enhance the kinetics of calcification. Manipulation of calcifying-fluid composition is thought to occur via Ca-ATPase controlled up-regulation of pH and replenishment of DIC by still poorly understood transport mechanisms. We have undertaken a global survey of both zooxanthellate and azooxanthellate corals across tropical and cold-water environments. Boron isotopic and elemental systematics from their carbonate skeletons have been used to determine calcifying-fluid pH, DIC and hence the Ω required to sustain biomineralisation across these diverse environments. We find that zooxanthellate bearing reef-building corals all have elevated pH (+0.3 to +0.5) above ambient seawater with the azooxanthellate tropical coral *Tubastrea*exhibiting even higher pH up-regulation (+0.5 to +0.6 pH units), similar to that found in azooxanthellate cold-water corals. The DIC characteristics are found to be systematically enriched (x1.5 to x2) relative to seawater which together with higher pH gives significantly elevated Ω (14 to 20). Thus combined up-regulation of pH, DIC and hence Ω in the calcifying fluid is a ubiquitous feature of aragonitic corals and crucial to their ability to calcify in a high $CO_2$ World.

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BENTHIC FORAMINIFERA AND CORALS AS INDICATORS OF WATER QUALITY IN WAR IN THE PACIFIC NATIONAL HISTORICAL PARK, GUAM, USA (Abstract ID: 28718)

Land-based sources of pollution threaten coral reefs, particularly in areas where streams from poorly managed watersheds drain onto reefs. In Guam, two such reef areas occur within War in the Pacific National Historical Park (WAPA). Since 2008, annual benthic cover surveys have been conducted to monitor the state of coral reefs within WAPA. Surface sediment samples were also collected at the monitoring sites on 2 to 3 occasions, and foraminifera in the samples were identified to calculate relative species abundances and FoRAM index (FI) values. Here, the benthic cover and foraminiferal datasets are combined to provide insight on short and long-term effects of water quality on the reefs at WAPA. Coral cover across the park is low in most areas, and distribution is not clearly related to the water quality gradient due to confounding stressors and historic catastrophic events. Coral cover has remained stable since 2008. However, changes in the foraminiferal community are evident across the water quality gradient. Relative abundance of symbiont-bearing foraminiferal species, most notably Amphistegina spp., and FI values are significantly related to water quality ($p<0.05$). FI values ranged from 5 near stream outputs to 9 at uninfluenced areas, and FI values declined at sites that were resampled across years. The shorter life span of foraminifera causes the communities to respond more rapidly to changes in water quality. Therefore, by paring coral and foraminifera monitoring, valuable information can be gained on short and long-term changes in water quality conditions in Guam.

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THE UNSEEN WORLD OF CORAL REEFS: BIODIVERSITY OF, AND HUMAN IMPACTS ON, THE CORAL MICROBIOME (Abstract ID: 29661)

Recent studies have revealed that the composition of diverse and abundant reef-associated microbial communities may influence coral resistance to local and global stressors currently threatening reefs worldwide. Combining benthic surveys, environmental data and 16S rRNA gene sequencing of*Montipora foliosa*, *Porites lobata* and overlaying reef water, this research evaluates the relationship between reef-associated bacterial communities and coral resistance by monitoring these bacterial communities before and during a thermal stress event at the island of Kiritimati, the world's largest atoll. Kiritimati is an ideal study site because it spans a large gradient of human disturbance (i.e. fishing pressure and nutrient runoff), with reefs highly degraded near the villages and becoming near pristine at remote sites. We evaluate 1) how bacterial community structure is related to individual coral colonies and overall coral community structure; and 2) how these relationships are influenced by human disturbance and a thermal stress event. We have data from 143 coral and water samples, focusing on two highly disturbed and two near-pristine sites. By quantifying coral reef microbial community composition and variability across ecosystem components, coral species, a temporal scale and a gradient of human disturbance, my research will provide new insights into microbial community ecology and the role of microbes in reef resistance to disturbance.

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DESIGNING AND FINANCING OPTIMAL ENFORCEMENT FOR SMALL-SCALE FISHERIES AND DIVE TOURISM INDUSTRIES (Abstract ID: 29740 | Poster ID: 562)

Effective enforcement can reduce the impacts of illegal, unregulated, and unreported (IUU) fishing, resulting in numerous economic, ecological, and social benefits. However, resource managers in small-scale fisheries often lack the expertise and financial resources required to design and implement an effective enforcement system. Here, a bio-economic model is developed to investigate optimal levels of fishery enforcement and financing mechanisms available to recover costs of enforcement. The model is parameterized to represent a small-scale Caribbean lobster fishery, and optimal fishery enforcement levels for three different stakeholder archetypes are considered: 1) a fishing industry only; 2) a dive tourism industry only; and 3) fishing and dive tourism industries. For the illustrative small-scale fishery presented, the optimal level of fishery enforcement decreases with increasing levels of biomass, and is higher when a dive tourism industry is present. Results also indicate that costs of fisheries enforcement can be recovered through a suite of financing mechanisms. However, the time-scale over which financing becomes sustainable will depend largely on the current status of the fishery resource. This study may serve as a framework that can be used by resource managers to help design and finance economically optimal fisheries enforcement systems.

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MONITORING AND REPORTING ON REEF HEALTH AND MANAGEMENT IN THE MESOAMERICAN REEF (Abstract ID: 29806)

The Healthy Reefs for Healthy People Initiative (HRI) is a collaboration of 65 partner organizations working to conserve the Mesoamerican Reef. HRI conducts biennial training courses and leads reef monitoring expeditions. There is an open access database

and annual meeting to discuss conservation priorities and issues within the region. Data are used by partners for local management purposes and by HRI to produce popular user-friendly Report Cards on the health of the reef. These reports are used by a variety of stakeholders from top political officials to fishermen. They include reef management recommendations which are evaluated for their degree of implementation in national level and Eco-Audits.The 2015 Report Card surveyed 248 sites finding most reefs remain in poor (40%) or fair (34%) condition. The number in critical condition (17%) declined while the amount in good or very good remains 9%. Coral cover improved since 2006, increasing from 10%-16% cover; although fleshy macroalgae also increased. Key herbivorous fish continue to increase in numbers, and have been fully protected in most of the region. Commercial fish have increased in biomass, although large groupers are rare outside of the fully protected zones of marine reserves.The 2016 Eco-Audit measured increased implementation of management actions, with improvements in 27 recommended management actions. This adaptive management framework allows for collaborative monitoring and management at a variety of spatial scales and has become a valuable tool for catalyzing public awareness and reef management actions.
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IN SITU METABOLISM, SOLAR HEATING, AND CONVECTIVE COOLING OF CORALS IN REEF ENVIRONMENTS (Abstract ID: 30002)

Incident bottom solar radiation is a source of significant heat energy to the benthos that must be either dissipated or stored. The dissipation and storage of this radiative heat has been shown to be a function of coral radiative properties, coral physical properties, and bottom mixing. Since coral surfaces heat and cool when there are changes in water temperature, coral substrate temperatures require time to thermally acclimatize. We used BEAMS (Benthic Ecosystem Acidification and Metabolism System) boundary layer measurements to quantify metabolism and measure both the radiative forcing (> 100 W/m2) and convective heating/cooling of corals at Palmyra Atoll (Line Islands) and Panama/Galapagos (eastern tropical Pacific) in 2014. This allowed us to investigate, for the first time, the diurnal cycle of metabolism and heat exchange and their potential impacts on coral reef systems. Since temperature is a critical control on the metabolism and bleaching response of corals, interactions between these physical parameters can have significant implications for coral health.

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INTEGRATING TELEMETRY-DERIVED DATA INTO SPATIAL DECISION-MAKING AND PRIORITIZATION FRAMEWORKS (Abstract ID: 29086)

Spatial planning strategies for conserving mobile marine species primarily focus on the protection of nesting or breeding sites and predictable coastal foraging habitats. Yet, conservation of these areas alone does not protect the migratory life stages, where many threatened mobile species continue to face population declines and mortality at sea. Although some protection of pelagic and key foraging habitats occurs incidentally, most pelagic pathways where species experience incidental mortality from artisanal fishing, commercial bycatch or targeted consumption remain exposed. We address this conservation deficiency by developing novel, quantative methods to incorporate telemetry and tracking data into conservation planning approaches. Our case studies illustrate how conservation planners can translate spatiotemporal variability in individuals movements into quantitative spatial planning objectives for highly mobile marine species. We investigate optimal spatial management strategies for pelagic protected areas (static/seasonal closures and gear modification zones) that minimize the probability of mobile species bycatch occuring across all taxa. Combining individual movement data with at sea threats from artisanal and commercial fishing, we identify areas and conservation actions that reduce the likelihoods of mortality from anthropogenic pressures.

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FUNCTIONAL SIGNIFICANCE OF SYMBIONT DIVERSITY WITHIN A CORAL-ALGAL ASSOCIATION (Abstract ID: 29449)

Research on various host-symbiont study systems has now recognized the importance of the diversity and organization of symbiotic species to mutualism function. The octocoral Briareum asbestinum, benefits from associations with endosymbiotic algae of the genus Symbiodinium for nutrient acquisition on oligotrophic reefs. Using stable isotope tracers of H13CO3- and 15NO3- we examined the nutritional quality of single species and mixed species symbiont assemblages. We found that the relative abundance of two species of symbionts in B. asbestinum, Symbiodinium A1 and B1 significantly influenced the acquisition rate of carbon and nitrogen by the symbionts and the translocation of those nutrients to the host. Our results demonstrated physiological differences between symbiont species with some evidence of competitive interactions among symbionts and/or host regulation of nutrient supply within mixed species Symbiodinium assemblages. However, complex ecological interactions among symbionts and between the host and symbionts were difficult to tease apart.

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ASSESSING RELATIVE RESILIENCE POTENTIAL OF CORAL REEFS TO INFORM MANAGEMENT (Abstract ID: 27911)

Ecological resilience assessments are an important part of resilience-based management (RBM) and can help prioritize and target management actions. Use of such assessments has been limited due to a lack of clear guidance on the assessment process. We provide that guidance from a resilience assessment undertaken in the Commonwealth of the Northern Mariana Islands (CNMI). We assessed spatial variation in ecological resilience potential at 78 forereef sites near the populated islands of the CNMI: Saipan, Tinian/Aguijan, and Rota. The assessment was based on measuring indicators of resilience processes and was combined with information on anthropogenic stress and larval connectivity. We found great spatial variation in relative resilience potential with many high resilience sites near Saipan (5 of 7) and low resilience sites near Rota (7 of 9). Criteria were developed to identify priority sites for six types of management actions (e.g., conservation, land-based sources of pollution reduction, and fishery management and enforcement) and 51 of the 78 sites met at least one of the sets of criteria. The connectivity simulations developed indicate Tinian/Aguijan are each roughly 10x the larvae source that Rota is and twice as frequent a destination. These results may explain the lower relative resilience potential of Rota reefs and indicates actions in Saipan and Tinian/Aguijan will be important to maintaining supply of larvae. The process we describe for undertaking resilience assessments can be tailored for use in coral reef areas globally and applied to other ecosystems.
http://www.sciencedirect.com/science/article/pii/S0006320715300926

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ESTABLISHING INDICATORS FOR A REPORT CARD IN A COMPLEX MARINE ECOSYSTEM. (Abstract ID: 27804)

Marine environmental report cards are an increasingly popular tool to communicate scientific results to stakeholders and communities. The challenge in developing a report card for complex marine habitats where changes in abundance, cover, distribution and

species can occur is establishing appropriate indicators to evaluate habitat condition. We developed an innovative approach for reporting on the condition of seagrasses as part of a broader report card on the environmental, social, cultural and economic health of one of Australia's largest multi-commodity ports located in the Great Barrier Reef World Heritage Area. The process used expert opinion to determine the best indicators of seagrass condition (above-ground biomass, meadow area, species composition), trialled four approaches to determine a baseline condition of each indicator, and defined five condition categories (very good - very poor) to grade each seagrass meadow relative to a baseline. Threshold levels for each condition category were determined based on the historical variability of each indicator in a meadow. The report card approach allowed for the presentation of a large amount of spatial information, including the location, condition, and the reason for each meadow's grade to be presented within a single map. This allowed not only for rapid comparison of seagrass condition across the range of meadows within the port, but also at a broader regional scale.

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SURVEY OF HAWAIIAN CORAL PHYSIOLOGY ACROSS A NATURAL RANGE OF TEMPERATURE AND PH GRADIENTS (Abstract ID: 29723 | Poster ID: 405)

Coral reefs worldwide are threatened due to ocean acidification and increasing seawater temperatures, yet the potential for coral to adapt or acclimatize to global change is poorly understood. Kaneohe Bay, Oahu, Hawaii, is an unusual reef location in that it currently experiences temperatures and $pCO_2$ concentrations not expected to occur on most Hawaiian reefs for another 30-50 years. We hypothesize that coral located in this reef have adapted to the above average conditions, and possess certain physiological and biogeochemical traits that facilitate this resilience. Four of the most dominant coral species (*Montipora capitata, Porites compressa, Porites lobata* and *Pocillopora meandrina*) from across the Hawaiian archipelago were surveyed from various different locations. These locations span the natural physical gradient in coral species distribution in Hawaii, and exhibit seasonal pH and temperature profiles that span conditions representative of today, through those predicted for 2050. We analyzed chlorophyll a concentration and tissue biomass in each species from each site. Preliminary results show that *M. capitata* varies between sites, whereas *P. compressa* does not. Further research is being conducted to determine if there is a link between variation in other physiological traits (lipid, protein and carbohydrate content) and variation in physical regimes among sites. These findings will further our understanding of which traits underlie coral resilience and/or adaptation capacity to future ocean condition on coral reefs.

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LINKING PATTERNS AND PROCESSES WITH SHIFTING BASELINES ON CORAL REEFS (Abstract ID: 27969)

Understanding how and why coral-reefs have changed in the last twenty to thirty years is crucial to sustaining coral-reef resilience. This is especially relevant for small-island nations that depend heavily on their marine resources, such as Kosrae, Federated States of Micronesia. We used a unique historical baseline to examine how Kosrae's coral and fish assemblages have shifted since 1986, and identify potential drivers of change. Key findings were that natural gradients in both fish and coral assemblages with wave exposure and watersheds have become amplified over that past three decades, as species are now more geographically restricted and metapopulation connectivity is reduced. Fishing access best predicted declining fish assemblage condition through time, and in turn, declining fish assemblages were correlated with negative changes to coral assemblages. This was especially pronounced on the leeward side of the island. A pollution proxy was further identified as a predictor of coral assemblage condition, but only in the modern time frame, and only in a few densely populated watersheds. Because large-scale disturbances have been minimal in Kosrae, declining coral condition was likely caused by the accumulation of small-scale disturbances through time, whereby compromised ecosystem resilience would have impeded coral recovery. Improving reef health on small islands like Kosrae will require prioritized management policies focused on local stressors, like over-fishing, that damage ecological resilience.

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FORTY YEARS ON: THE SCIENTIFIC LEGACY OF THE 1973 'STODDART EXPEDITION' TO THE NORTHERN GREAT BARRIER REEF. (Abstract ID: 28413)

The work of the 1973 Royal Society and Universities of Queensland Expedition lead by David Stoddart shed new light on the history and morphological development of the northern Great Barrier Reef system. Evidence from shallow coring, surface geomorphology, lithology of exposed limestone rocks, superficial sediment accumulations, vegetation patterns and the historical record of sea level derived from radiometric dating suggested a sequence of reef and island development in Holocene times. An assessment of the results of the expedition over forty years on reveals some of the conclusions made subtle incremental advances to our comparative knowledge of reefs and reef islands as well as providing a robust launch-pad for others. But the tightly constrained Holocene sea level history provided the strongest demonstration to date that there were regional differences in sea level and not just one global eustatic story; that has been the expeditions most lasting legacy.

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CHALLENGES AND GUIDANCE INTEGRATING CLIMATE CHANGE INTO CORAL REEF PLANNING AND MANAGEMENT (Abstract ID: 28890)

Coral reef ecosystems, including the communities that depend upon them, are particularly vulnerable to climate change. However, reef managers and conservation planners face a number of challenges integrating potential climate change impacts into their conservation strategies. They may lack access to climate model data, or the data may be too coarse for site-based planning. Uncertainties in climate data and outputs make it challenging to interpret and apply in conservation decisions. Guidance is needed on how to identify the most appropriate tools and outputs for assessing climate impacts, and how to apply climate projection data to decision support frameworks including how to weight these data alongside other social and ecological factors. This session will outline these challenges and explore how they are being addressed through the Reef Resilience Network. The Network provides reef managers and practitioners with access to the latest science and management tools, strategies, and recommendations to incorporate climate change and others stressors into coral reef planning and management. A web-based toolkit includes an overview of climate stressors and projections, guidance for managing such stressors including case studies, and best practices addressing social and ecological resilience.

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ONTOGENETIC MIGRATION OF SNAPPER LINKS FOOD WEBS ACROSS A TROPICAL SEASCAPE IN THE RED SEA. (Abstract ID: 29649)

Many socio-ecologically important coral reef fishes undergo impressive ontogenetic migrations across tropical seascapes, linking distant habitats, populations, and food webs. We examined ontogenetic migration patterns of Ehrenberg's Snapper (*Lutjanus ehrenbergii*) populations on coastal and oceanic coral reefs in the Red Sea using a new otolith-based compound-specific stable isotope method. We then applied a new amino acid isotope fingerprinting approach within a Bayesian mixing model framework to identify the sources of primary producers (phytoplankton, coral, macroalgae, seagrass, and mangroves) fueling the local snapper populations during different stages of their ontogenetic migration. We found that seascape configuration played a critical role in determining migratory connectivity of *L. ehrenbergii* among essential habitats. We also found that *L. ehrenbergii* occupied fundamentally different resource niches associated with different phases of their ontogenetic migration. For instance, adult *L. ehrenbergii* on shelf reefs often relied heavily on a seagrass-based food web as juveniles before switching to a macroalgal-based food web once they migrated out to the adult population on shelf reefs. Conversely, adult *L. ehrenbergii* on offshore oceanic reefs typically showed minimal ontogenetic change in either habitat or baseline carbon source, relying heavily on a water column phytoplankton-based food web throughout their lives. Our work provides insights into the roles that ontogenetic migration plays in linking essential habitats and food webs across tropical seascapes.

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RECENT DAMAGE TO OFFSHORE CORAL REEFS IN THE SOUTH CHINA SEA: QUANTIFICATION, IMPLICATIONS AND POTENTIAL SOLUTIONS (Abstract ID: 28225)

The offshore reefs of the South China Sea may be important in preventing extirpation of overharvested species throughout the region. Overlapping jurisdictional claims by bordering nations have led to actions, including military base construction, intended to support these claims. This has resulted in unprecedented rates of essentially permanent coral reef decline due to island building and reinforcement. Channel and harbor dredging has permanently altered important reef processes. Additionally, the widespread dredging of materials for the island construction activities has led to damage of decadal or

longer time scales. The total area damaged, in conjunction with the growing levels of over-harvesting, may be enough to substantially impact regional fisheries production and destabilize populations of many species. Consequent hardships may lead to more pressure to strengthen claims, resulting in an intensifying spiral of ecological degradation and political tension. A potential means to halt this spiral is to institute a renewable multilateral treaty consisting of a freeze on claims, a freeze on claim-supportive activities, and a joint plan for resource management. One embodiment of such as plan would be a Greater Spratly Islands Peace Park.
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LARVAL DISPERSAL AS A MECHANISM FOR CORAL PERSISTENCE ON REEF COMMUNITIES (Abstract ID: 29852)

Connectivity through larval dispersal is thought to be a major determinant of coral persistence, especially in terms of the recovery potential for populations that suffer catastrophic mass bleaching events. However, our understanding of the interactions between coral recruitment and mortality on reefs is limited, particularly when reproduction occurs in a discrete, seasonal manner as in most stony coral species in the Indo-Pacific. Here, we model coral-algal competition on a reef patch, accounting for larval input from within the patch and an external source. We incorporate coral recruitment in two ways, with larvae arriving either seasonally or continuously through time. Our goals were to (1) determine the conditions under which connectivity can offset the effects of higher mortality due to bleaching and (2) evaluate the impact of recruitment and mortality on the stability of coral- vs. algal-dominated regimes. In general, incorporating coral recruitment, even seasonally, erodes the basin of attraction associated with algal-dominated states. This allows coral to persist in a parameter space that, without larval input, would lead to algal dominance. When coral cover is low, there exists a threshold number of arriving larvae to a patch that will stimulate coral recovery; this threshold depends on the initial algal cover. If algal cover is beyond a critical level, however, no amount of larval input can induce a shift to coral dominance. In this case, there is an increase in the importance of within-patch processes in setting the trajectory towards a particular reef state.

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SEARCHING FOR CODIVERGENCE AMONG CORALS AND BACTERIA WITH THE GLOBAL CORAL MICROBIOME PROJECT (Abstract ID: 28101)

It has been previously demonstrated that microbial communities associated with coral animals display patterns of host species-specificity. We hypothesized that important members of the coral microbiome have codiversified with their hosts, that these members can be detected among a large community of associates, and that the degree of their codivergence will vary among coral groups depending on certain life-history traits such as reproductive method. As part of the Global Coral Microbiome Project (GCMP), we have systematically sampled more than 1500 healthy individuals from ~130 species of corals in ~20 Scleractinian families, plus anthozoan and hydrozoan 'outgroups', and abiotic controls. We have separately extracted DNA from the mucus, tissue, and skeleton of each of these samples, and have used high-throughput sequencing of the 16S marker gene to assess bacterial community composition. We have begun to test our hypotheses by applying novel bioinformatic techniques. Preliminary data suggest that at least one bacterial taxon, *Endozoicomonas sp.*, is distributed in a manner consistent with coevolution on large timescales. We have also contrasted the variance in microbial communities explainable by sampling location and host phylogeny, finding distinctive patterns in each. The data generated by this project are freely available to the community, providing a large resource to which future data can be compared.

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CARBON-CYCLING ON CARIBBEAN CORAL REEFS: THE INCREASING ROLE OF GIANT BARREL SPONGES (Abstract ID: 28192)

Benthic suspension feeders support a number of ecosystem processes, including benthic-pelagic coupling and the cycling of carbon and nutrients. Sponges now dominate Caribbean reefs, with the giant barrel sponge*Xestospongia muta* playing the largest role. Barrel sponge populations increased by 122% for 2000-2012 on Conch Reef, Florida Keys, with a 40% increase in volume (approx. 2 liters of sponge tissue per square meter). Barrel sponges are estimated to overturn the water column every 2-18 days, and selectively feed on bacteria and other picoplankton, but have a diet that is mostly (~70%) made up of dissolved organic carbon (DOC). Using demographic data from 2000-2012, and measurements of filtration rates of particulates and DOC, we parameterized a stage-based matrix model of carbon flux for *X. muta* to investigate the demographic mechanisms that change benthic-pelagic coupling. Population-mediated carbon flux increased over time with increasing sponge density and volume, with the largest individuals making the greatest contribution. Elasticity analysis revealed that the growth of sponges in all stages, the survival of sponges in the two largest stages, and the production of new recruits by the largest sponges had the greatest influence on changes in carbon flux. Projections indicated that population-mediated carbon flux will continue to increase under present conditions; thus, *X. muta* is expected to play an even larger role in the transfer of carbon from the water column to the benthos on Caribbean coral reefs.

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MULTIFACETED IMPACTS OF THE STONEY CORAL PORITES ASTREOIDES ON PICOPLANKTON ABUNDANCE AND COMMUNITY COMPOSITION (Abstract ID: 28084 | Poster ID: 146)

Picoplankton foster the essential recycling of substrates in the oligotrophic waters sustaining coral reef ecosystems. However, how specific interactions between corals and planktonic bacteria and archaea (picoplankton) contribute to reef productivity are not well resolved. Here, we utilized mesocosm experiments to investigate how corals and coral mucus influence picoplankton and nutrient dynamics in reef waters. Over 12 days, we tracked nutrient concentrations, picoplankton abundances and taxonomic composition of picoplankton using direct cell-counts, sequencing of SSU rRNA genes and fluorescent in situ hybridization-based abundances of dominant lineages in the presence or absence of Porites astreoides corals or their mucus. Our results demonstrate that when corals are present, Synechococcus , SAR11 and Rhodobacteraceae cells are preferentially removed and Alteromonadaceae and Oxalobacteraceae cells increase in abundance. When corals were absent, their exudates enhanced the growth of diverse picoplankton, including SAR11 and Rhodobacteraceae. A ten-fold increase in nitrate concentration, apparently caused by nitrogen remineralization within the coral, may have further facilitated the growth of these taxa. In contrast, the addition of mucus resulted in inconsistent responses by the picoplankton community. This study presents evidence of the multifaceted influences of corals on picoplankton, in which the coral holobiont selectively removes and promotes the growth of diverse picoplankton and remineralizes nitrogen, thereby fostering reef productivity.

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INDUSTRY AND RESEARCH COLLABORATION TO LEVERAGE CORAL REEF SCIENCE FOR ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT (Abstract ID: 28142)

Woodside Energy Ltd and the Australian Institute of Marine Science (AIMS) enter a new working partnership in 2016 based on over twenty years of collaborative scientific studies supported by various funding models. The studies have underpinned impact assessment for upstream oil and gas activities and proposed developments in the offshore waters of Western Australia. This showcase includes: one of the world's key long-term monitoring programs of a remote oceanic reef system including mesotrophic coral communities, seismic survey potential impacts, updated baseline for the World Heritage Areas of Ningaloo Reef and Shark Bay and the repurposing of industry acquired geophysical data for habitat mapping to support environmental risk assessment.

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GREAT BARRIER REEF MARINE SOUNDSCAPES: LIZARD ISLAND - A CORAL REEF CASE STUDY (Abstract ID: 29200)

Marine soundscapes are acquiring a growing level of social and academic awareness. Advancements in technology and ecological modelling now provide opportunities to progress research and monitoring programs, but large knowledge gaps remain in the following key areas: soundscape spatio-temporal patterns, methodology and sound-source identification. This presentation provides a synopsis of Lizard Island marine soundscapes. Great Barrier Reef marine soundscapes have received limited coverage, making this a rare and important study. Sets of continuous sound recordings were

collected at field sites across a number of seasons (2014-2016). Several prominent fish choruses were identified at specific locations around the island, exhibiting a range of different temporal patterns. Cyclone Nathan hit Lizard in March 2015 causing widespread damage to the Island's coral reef. A comparison of reef soundscapes prior and one year post-cyclone will be presented. Simultaneously measuring environmental co-variables at a site level is an important step in identifying soundscape contributors and explaining observed patterns. Environmental co-variables, wind speed, temperature and relative light levels were collected at field sites on a 10 minute duty-cycle. Additional information on salinity, pH and tide height was obtained from open-access oceanographic datasets. The influence of ship-radiated broadband noise from a nearby commercial shipping lane had a significant influence on the underlying soundscape. Masking of fish choruses up to several hours was common in the presence of passing ships.

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CORAL TRAIT DIVERSITY AND FUNCTIONAL COLLAPSE ON CARIBBEAN CORAL REEFS (Abstract ID: 27900)

To explain patterns of shifting function in coral assemblages, we must consider how species differ in their contribution to ecosystem processes, and how they respond to local and global stress. Here, we use a multi-trait analysis to measure the relative contribution of Caribbean corals to numerous reef-level processes, such as reef accretion, primary productivity, and habitat provision. We identify coral functional types (CFT's) in the Caribbean, allowing us to explicitly measure functional diversity and redundancy in coral communities. By analysing the abundance of corals during multi-decadal shifts in community structure, we show that in Jamaica, coral species of similar functional type exhibit similar responses to disturbance (low response diversity), such as hurricanes and bleaching events. This, along with unprecedented stress from the loss of herbivores, has led to regime shifts, whereby all corals, and coral functions have been lost. Low response diversity is also evident on degraded reefs that are recovering, resulting in alternate coral assemblages, with substantially different biogeochemical, trophic and constructional processes. This study asserts that the stability of function in ecosystems is largely a product of the association between 'response' and 'contribution' traits in critical groups of organisms.

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SPECTRAL SIGNATURES OF BRAZILIAN CORAL REEFS (Abstract ID: 29664)

Studies involving spectral signatures are important as they provide a base for the interpretation of data obtained through remote sensing at different levels, allowing better mapping and environmental monitoring. An investigation of the spectral signatures of Brazilian corals and hydrocoral includes as selected species Agaricia agaricites, Favia gravida, Mussismilia braziliensis, Mussismilia harttii, Milepora alcicornis, Porites astreoides and Siderastrea stellata. Spectral signatures were collected using a portable FieldSpec 3 Hi-Res spectroradiometer and subsequently processed using two techniques: mean and derivative analysis, using the first and the fourth derivates. Results classify the coral P. astreoides within the blue group, while the hydrocoral and other corals fall within the brown spectral group. Features in the first derivate are used to distinguish some of the species, while the fourth derivate presents positive and negative peaks that confirm the differences among species observed in the first derivate. Possibly, fluorescent or non-fluorescent pigments present in the tissue of corals were responsible for the differences in spectral signatures. Thus, apparently, it will be possible to distinguish some coral species through their spectral signatures using data about the different fluorescent and/or non-fluorescent pigments present in corals tissue. The final objective is to use these spectral signatures to classify WorldView-2 satellite imagery into coral cover maps.
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COMMUNICATING THE SCIENCE OF THE MEXICAN CORAL REEFS TO SUPPORT THEIR PROTECTION AND CONSERVATION (Abstract ID: 28727)

Mexico is a privileged country thanks to its location in the tropics and having coastlines on two oceans, where coral reefs and their associated organisms develop, having a direct and indirect impact on the use of resources that sustain national economy. However, it is remarkable the ignorance that the general public has on organisms and phenomena associated with these ecosystems. The purpose of the project was to improve the awareness in the society about the current situation of the Mexican coral reefs and the studies that students and scientists are producing and publishing. Results included products aiming several groups of people: two types of radio spots; an updated web site to support students and scientists interested on coral reefs, but also complemented with information for the general public; workshops on science journalism focused on scientific meetings, particularly about coral reefs; field trips to two relevant coral reefs in the Pacific and Caribbean to produce coverage that was published in 12 press and TV notes; several talks to students and general public in different cities; and a colorful booklet with information about coral reefs. Most of the products can be found in the Mexican Coral Reef Society web site (www.somac.org.mx) and the radio spots can be downloaded freely (soundcloud.com/arrecifes-coralinos-somac). The information and products include valid information that can be use for some years, increasing the chances to reach more people and improving the knowledge on coral reefs, which can help in their protection and conservation.
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LEARNING NETWORKS AS A POWERFUL TOOL FOR INCREASING EFFECTIVENESS OF CORAL REEF CONSERVATION (Abstract ID: 30116)

Collaborative management and adaptive learning are some of the most effective and powerful ways to engage stakeholders to improve local management at the site level. Especially in the marine realm, where coastal areas and reef ecosystems are in the public domain, a particpatory and community-based approach is necessary. Inspired by the Locally Managed Marine Area (LMMA) Network, The Maui Nui Makai Area Learning Network was established in 2013 by 6 communities from Maui, Lanai and Molokai and 2 supporting organizations. This emerging network would like to share their experiences and lessons learned on how to form networks that build capacity for communities that rely on the health of their marine and coastal environments. Success stories and challenges with community outreach, engagement, co-management, governance, developing appropriate bio-cultural indicators and traditional knowledge will be discussed and shared by community leaders from the Maui Nui Makai Network to provide examples of how scientists and reef managers can better engage and support communities in improving coral reef conservation and fisheries management.

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THE COMMUNITY WATERSHED SNAPSHOT: LOCAL MEASURES OF AHUPUA'A HEALTH (Abstract ID: 30043 | Poster ID: 571)

Hawaii Conservation Alliance's (HCA) Community Watershed Snapshot is a status report on the health of our watersheds produced from geospatial data gathered by the community. This initiative is the first community-based conservation effort of HCA, under the Effective Conservation Program (ECP). The ECP's goal is to facilitate effective conservation of Hawai'i's native ecosystems in terrestrial, aquatic, and marine realms by measuring and maximizing effectiveness, strategic planning, and success of the collective conservation community through active management, protective designation, and stakeholder support for a stable track record of expanding biodiversity. In 2013, HCA consulted with local leaders and stakeholders from eight communities across the main Hawaiian Islands on how best to measure the health of local watersheds. Community representatives identified a set of mauka (terrestrial), makai/wai (ocean/fresh water), and na'ike (social-economic) factors that they believe are important in understanding the status ("snapshot") of the health of their ahupua'a. Following formal review and consideration by HCA members, a set of Watershed Snapshot Metrics was endorsed by HCA in 2014. During 2015 and 2016, volunteer communities have begun to implement the watershed snapshot measures. Participating communities aim to use the information gathered through the watershed snapshot measures to inform and advance their community-based natural resource management efforts.
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HUMANS AND SEASONAL CLIMATE VARIABILITY THREATEN LARGE-BODIED CORAL REEF FISH WITH SMALL RANGES (Abstract ID: 27844 | Poster ID: 422)

Coral reefs are among the most species-rich and threatened ecosystems on Earth, yet the extent to which human stressors determine species occurrences, compared to biogeography or environmental conditions, remains largely unknown over broad spatial scales.

With ever-increasing human-mediated disturbances on these ecosystems, an important question is not only how many species can inhabit local communities, but also which biological traits determine species that can persist (or not) above particular disturbance thresholds. Here we show that human pressure and seasonal climate variability are disproportionately and negatively associated with the occurrence of large-bodied and geographically small-ranging fishes within local coral reef communities. These species are 67 % less likely to occur where human impact and temperature seasonality exceed critical thresholds, such as in the marine biodiversity hotspot: the Coral Triangle. Our results identify the most sensitive species and critical thresholds of human and climatic stressors, providing opportunity for targeted conservation intervention to prevent local extinctions.

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IMPORTANCE OF HETEROTROPHIC FEEDING FOR *PORITES CYLINDRICA* AS AN ALTERNATIVE SURVIVAL STRATEGY. (Abstract ID: 29224)

Emissions of anthropogenic carbon dioxide have been increasing both the temperature and acidity of the oceans and consequently challenging the future of many calcifying marine organisms such as corals. High diversity of corals and their varying response to climatic change, make understating future changes important. Previous research suggests *Porites cylindrica* can survive several months longer than other species in a bleached state. This project aims to establish how heterotrophic feeding may help *P. cylindrica*survive and grow in the absence of autotrophic energy. Unbleached and heat bleached corals where kept under four different feeding treatments (particulate or dissolved organic carbon, glucose and not fed) and two light regimes (light/dark or dark only). Coral survival was the same across all treatments, however some bleached corals maintained in the dark showed signs of disease. Different food groups had no significant effect on calcification rates measured as changes in buoyant rate. An interaction between light and coral bleaching status was observed with only unbleached corals exposed to light/dark cycles showing significant calcification over the 14-day experimental period. Tissue properties will be analyzed to determine whether *P. cylindrica* trades calcification for tissue growth in the presence of food when photoassimilates are absent. The results obtained to date consistent with the hypothesis that the promotion of coral calcification by dinoflagellates is not solely based on the provision of energy to the host.

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PETER MINSHALL'S WATER COLOURS: AN INNOVATIVE APPROACH TO CORAL REEF CONSERVATION AND CONSERVATION FINANCING IN TOBAGO (Abstract ID: 28740)

The Buccoo Reef Marine Park (7km2 of coral reefs, seagrass and mangroves) is Tobago's biggest tourist attraction, earning an estimated US$43.5 million (40% of the island's tourism income) annually. It was designated as a protected area in 1973; a RAMSAR site in 2005; and an Environmentally Sensitive Area under Trinidad's 2001 Environmentally Sensitive Area Rules. As legal protection has increased mean live coral cover has decreased, with the greatest decline in shallow water (<3m), from 23.20% in 1985 to 5.63% in 2009. Lack of funds to manage the Park has contributed to these declines. Government funding for the Park was just US$56,000 in 2009. A 2010 willingness-to-pay study suggested that US$11.72 could be charged to visit the reefs. However, charging for previously free activities has proved difficult (e.g., imposition of a US$3 access fee at Pigeon Point, the Park's beach, led to protests and the fatal shooting of a fisherman in 2000). In an effort to independently and sustainably finance the Park, Trinidadian Carnival Artist Peter Minshall, creator of the Opening Ceremonies for the Barcelona, Atlanta, and Salt Lake City Olympics, is making Water Colours—an undersea artwork at Buccoo. This new, culturally-appropriate tourist attraction will raise funds through admission fees and memorabilia sales. This paper describes the IADB-funded first phase of the project including: the design of the sculptures; the creation of the Water Colours Trust Fund; and the socio-economic and marketing studies for the attraction.

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FUNCTIONAL BIOGEOGRAPHY OF NOMINALLY HERBIVOROUS FISHES (Abstract ID: 28649)

Herbivorous fishes are known to be important components of reef systems worldwide, but to date no comprehensive large-scale study of their functional structure has been performed. Here, we describe the global distributional patterns of herbivorous fishes on tropical reefs, and the relative importance of their main feeding modes according to large-scale biogeographical variables. We compiled a database on the occurrence of 550 herbivorous fish species at 170 sites worldwide. Each species was classified according to six functional traits and functional entities (FEs) defined as a combination of each one of these traits. We found markedly differences on richness and proportion of herbivores among region, with higher values in the Indo-Pacific (IP), in contrast with Eastern Pacific (EP) and Atlantic. The functional structure of the herbivore assemblages presented a similar pattern with functional richness positively related to richness. Browsers exhibited higher proportions in EP and Atlantic and peripheral areas of the IP, and scrapers were more important in the Western Atlantic and EP. The results suggest that different environmental and historical factors have shaped the present day structure of herbivorous fishes assemblages. Patterns of functional structure observed may have important implications for coral reef conservation and management.

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TEMPORAL VARIATIONS IN PHOTOCHEMICAL EFFICIENCIES OF ALGAL SYMBIONTS IN BENTHIC FORAMINIFERA AND ANTHOZOANS IN THE FLORIDA KEYS (Abstract ID: 29391 | Poster ID: 286)

Pulse-amplitude modulated (PAM) fluorometry is widely used to study photochemical efficiency in photosynthetic organisms. This project compared photochemical efficiencies of the algal symbionts of reef organisms by time of year and habitat depth. Maximum quantum yields (Fv/Fm) were measured from visibly healthy colonies of three species of zooxanthellate anthozoans (in situ) and specimens of the foraminifer*Amphistegina gibbosa*, which hosts diatoms. Because of their small sizes, data for the latter were taken in the laboratory as soon as possible after field collection. Field work was carried out near the equinoxes and solstices in 2012-13 at Tennessee Reef, Florida, USA, at 6 m and 18 m depths. At 6 m, the Fv/Fm means for *Palythoa caribaeorum* differed only between summer (0.55 +/- 0.01) and fall (0.63 +/- 0.01) 2012. No significant differences with time were found for *Siderastrea siderea* at 6 m (0.64 +/- 0.01). The mean Fv/Fm for *S. siderea* at 18 m was significantly higher in winter 2012 (0.71 +/- 0.01) than in spring 2013 (0.65 +/- 0.01). No significant differences were found for*Montastraea cavernosa* at 18 m over time (0.68 +/- 0.01). The Fv/Fm means for*A. gibbosa* from 6 m (0.719 +/- 0.01) were lower than their counterparts at 18 m (0.735 +/- 0.01). The overall trends in photochemical efficiency of *A. gibbosa*and the anthozoans were lower, more variable yields under higher potential for photic stress, that is, both shallower depths and months with highest solar irradiance.

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GENETIC DIVERSITY OF THE SYMBIOTIC DINOFLAGELLATES (SYMBIODINIUM) ON THE CORAL PORITES PANAMENSIS IN THE EASTERN TROPICAL PACIFIC (Abstract ID: 29521)

The reef-building corals have a symbiotic relationship with dinoflagellates of the genus *Symbiodinium*. This symbiosis involves many interactions processes that lead to genetic changes and adaptations. In this study, we describe the genetic diversity of the endosymbiotic dinoflagellates (*Symbiodinium*) within the coral *Porites panamensis* in the Eastern Tropical Pacific. The genetic diversity of symbiont was accesed using the non-coding region of the minicircle of chloroplast PsbA. We analyzed samples from the Gulf of California, West coast of Mexico and Costa Rica. We found four phylogenetic lineages (L1-L4) belonging to *Symbiodinium* Clade C in the Eastern Tropical Pacific. The lineage 1 was composed by six groups distributed in the Gulf of California. We show that the genetic diversity of*Symbiodinium* in *P. panamensis* is high, since we found 35 unique haplotypes in 39 sequences analyzed. Changing environmental conditions across the Eastern Tropical Pacific have led to the existence of distinct symbiont-host combinations. This environmental situation combined with the reproductive form of the coral and the vertical transmission of symbionts (i.e. from parents to offspring) allows the high genetic diversity of*Symbiodinium* in *Porites panamensis*. This could be an explanation of how the host and its symbionts have diverged in many different phylogenetic groups that belong to distinct localities across the Eastern Tropical Pacific.

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OPTICAL PROPERTIES INVOLVED IN THE EFFICIENCY OF LIGHT ABSORPTION OF CORAL FAVIA FRAGUM (Abstract ID: 29732 | Poster ID: 45)

The structural complexity of corals provides them the capacity to regulate the amount of light they receive, by absorbing a variable fraction of the photons and transmitting, reflecting or scattering the rest. The aim of this study was to describe the optical properties of Favia fragum at two developmental stages with different skeletal thicknesses: 35 juveniles with skeletal thicknesses less than 0.5 cm and 25 adult colonies with skeletal thicknesses greater than 1 cm were used. Measurements of transmittance and reflectance were performed and from these measures absorbances and absorptances were estimated. The number of symbionts, their chlorophyll a content and the chlorophyll a specific absorption coefficients (a*) were determined. The transmittance value recorded in the skeletons of juveniles was close to 3%. Reflectances at 675 nm was 12% in adult colonies and 37% for the juveniles with absorptance values of 88% and 62% respectively. Juveniles had a higher pigment content/symbiont and lower symbiont densities than adults. Comparison of a* values showed that adults are up to 1.6 times more efficient at absorbing light than juveniles. Loss of light by transmittance is reduced with increasing skeletal thickness and is related to the increased light absorption efficiency in adult colonies. The balance between cell density and symbiotic photosynthetic pigments strongly influence the efficiency of light absorption in corals with different skeletal thicknesses.

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A PHYLOGEOGRAPHIC APPROACH TO STUDY CORAL REEF REFUGES IN SOUTHWEST ATLANTIC (Abstract ID: 29031 | Poster ID: 68)

Along Pleistocene, at least 30 cycles of repeated global cooling and warming caused sea level variations that dropped as much as 120 m during the Last Glacial Maximum (~ 21000 y BP). Coral reef ecosystems, which mainly occur in shallow, warm and oligotrophic waters, were drastically affected by these events. For Southwest Atlantic, where reef formations extend mainly in a north-south direction, the Abrolhos Bank has been hypothesized as an important coral reef refuge, a main source of the propagules that formed the present banks. We used phylogeographic tools to a first approach to this hypothesis. We used nuclear DNA fragments (Signal Recognition Particle 54-kDa – SRP54) to analyze 11 samples of the widely distributed Brazilian coral Siderastrea stellata from three localities in a range of 630 Km from Abrolhos Bank to the north. We observed overall high haplotype diversity. Genetic structure was detected, however, no isolation-by-distance was observed. The haplotype network presented two main groups separated by at least 15 mutational steps. Although our results cannot discard Abrolhos as a refuge, they point to the presence of two distinct areas that remained isolated for some time and from where our sampled banks had received migrants. Additional investigations, extending the sampled area, using more loci and coalescence based analysis may provide more details and even may detect other putative areas that might had been suitable for coral species during the periods of lower sea levels.

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RAMIFICATION PATTERNS OF THE THREATENED CORAL ACROPORA CERVICORNIS: IMPLICATIONS FOR RESTORATION ACTIVITIES (Abstract ID: 30097)

Acropora cervicornis is a threatened Caribbean coral that depends greatly on branch fragmentation to proliferate. Thus, understanding the patterns of branch formation is essential for the development of management and conservation initiatives. Studies directed at describing the branching dynamics of A. cervicornis are nonetheless, scarce. In this study, we examined the patterns of branch morphogenesis in 100 colony fragments that were transplanted to two reefs with different light regimes. Five morphometric variables (e.g. location of branch formation) were measured for one year. Branching complexity was evaluated by means of two indices: the Horton-Strahler bifurcation ratio (Rb) and the Carrillo-Mendoza branching index (CM-BI). We also constructed a simple discrete model that estimates the number of harvestable branches and contrasted the model's prediction with the observed branching dynamics. In general, we found that 1) growth and branching rates were higher at the site with the lowest light intensities, 2) the CM-BI was more appropriate than the Rb to describe the branching structure of A. cervicornis, and 3) the number of branches formed during the study was accurately predicted by the simple mathematical model. We will discuss how our results can be used to guide management and conservation plans focused on this key species.
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THE IMPORTANCE OF LONG-TERM MONITORING TO ASSESS THE EFFECTIVENESS OF SEAGRASS BEDS WITHIN A MARINE PROTECTED AREAS NETWORK IN PALAU, MICRONESIA (Abstract ID: 28580 | Poster ID: 555)

Seagrass beds provide a number of ecosystem goods and services which include nursery grounds, habitat for fish, carbon sequestration, sediment trapping, and nutrient filtration. The loss of seagrass beds often leads to a decrease in fish and invertebrates' populations, increase in sedimentation, and impacts adjacent coral reefs. In Palau, several seagrass beds are protected and are part of the Palau Protected Areas Network (PAN) that aims at effectively conserve marine resources. However, since the implementation of the PAN, few studies have looked at the impacts of protection on seagrass bed communities. With long term monitoring data collected bi-annually since 2011 on fish, invertebrates and seagrass communities, this study showed the effect of protection at four spatially spread seagrass beds. Results demonstrated that protected seagrass beds had higher marine resources than their respective non-protected reference sites. In addition, fish and invertebrates densities and seagrass cover within MPAs showed different trends among the four MPAs. This implies that protection from fishing solely is benefiting seagrass beds but to a certain extent. Other non-measured variables such as water quality should be considered in the future for more effective resource management.

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EVALUATING THE CONTRIBUTION OF HOST GENOTYPE, SYMBIODINIUM COMMUNITY, AND BLEACHING HISTORY IN REPEATEDLY BLEACHED ACROPORA CERVICORNIS NURSERIES (Abstract ID: 29840)

*Symbiodinium* community composition, host genotype, and bleaching history play key roles in determining holobiont thermal tolerance and bleaching susceptibility. The hyperthermal events in both summers of 2014 and 2015 severely affected *Acropora cervicornis* propogated within South Florida coral nurseries and provided an opportunity to study these factors. These nurseries rigorously track numerous different clones or genets, each containing many clonal individuals or ramets, allowing for study of diverse genotypes. Bi-monthly to monthly sampling of these corals from June 2014 prior to thermal stress through September 2015 tracked these corals through both mass bleaching events. High throughput sequencing has begun to revolutionize the study of coral associated *Symbiodinium* communities, but it has not yet been applied to temporal studies of coral bleaching recovery, when *Symbiodinium* communities are most dynamic. We employed high-resolution pair-end Illumina sequencing to track *Symbiodinium*communities using the cp23S rDNA through time points before, during, and after the bleaching events. Our study evaluates the roles of coral host genotype, *Symbiodinium* community composition, and bleaching history as potential determinants of bleaching susceptibility. Here we address the relative contributions and interactions of each of these factors. More importantly, this monitoring effort explores the potential for a key reef building coral to adapt or acclimate to increasingly frequent thermal stress imposed by climate change.
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TERRIGENOUS SEDIMENT DYNAMICS IN A SMALL, TROPICAL FRINGING-REEF EMBAYMENT, AMERICAN SAMOA (Abstract ID: 30005 | Poster ID: 453)

Watershed disturbance can increase sediment stress on corals, but clearly linking sediment sources to reduced coral health poses significant challenges for environmental managers. This study provides a template for managers in remote, sediment-impacted environments, who wish to quantify relationships between watershed sediment sources, water circulation over the reef, and the spatial distribution of sediment accumulation on the reef. In-stream sediment yields were monitored downstream of undisturbed forest, a quarry, and village, before and after sediment mitigation in the watershed. An event-wise sediment budget showed the disturbed quarry and village contributed about 70% of sediment loading to the embayment. Following sediment mitigation at the quarry, sediment loading to the embayment was significantly reduced. An empirical model of water circulation and residence time over the reef was developed from GPS drifters (5 drifters, 30 deployments) and acoustic current meters. Shortest residence times were on the exposed South Reef near breaking waves, and longest over the reef flat close to shore and sheltered northwest corner of the embayment. This circulation pattern explained the significantly higher accumulation of terrigenous sediment on the North Reef, than on the South Reef, as measured by tubes and SedPods. The sediment plume discharged during storms was deflected over the North Reef, leading to increased sediment accumulation on corals and reduced coral health. Conversely the South Reef remains relatively healthy due to the observed circulation pattern that prevents fine, terrigenous sediment from being transported over the South Reef.

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THE ROLE OF LETHAL AND SUBLETHAL PREDATION ON CROWN-OF-THORNS STARFISH POPULATIONS (Abstract ID: 29081 | Poster ID: 208)

The removal of predators through over-fishing has been proposed as one contributing factor in crown-of-thorns starfish outbreaks, but the role of predation in controlling crown-of-thorns starfish populations remains controversial. Here, we explore the frequency of predation events, as well as the consequences of sublethal predation on crown-of-thorns starfish. Based on over 3500 crown-of-thorns starfish collected from the Great Barrier Reef (Australia), approximately 50% of the individuals had missing or short arms (indication of past predation events), irrespective of the level of fishing restrictions placed on reefs. This begged the question at what point predation becomes lethal and what the consequences of sublethal predation are on fecundity. In an experimental trial, sections of crown-of-thorns starfish as small as 1/8 survived over several months and showed signs of regeneration. However, survival of sections appears to be dependent on the size of the starfish, with sections of large mature animals less likely to survive. Additionally, fecundity as a function of arm length was estimated for 40 individuals, but remains to be analysed at the time of abstract submissions. Despite the biological and physical defences of crown-of-thorns starfish, this study showed that predation events are a frequent occurrence. Although fishing restrictions in Australia appear to have little impact on the frequency of sublethal predation, predators are likely to have some impact on crown-of-thorns starfish populations.

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STUDYING MULTI-STRESSORS EFFECTS IN CORAL REEF ORGANISMS: PERSPECTIVES RELATED TO THE USE OF RADIOTRACER TECHNIQUES (Abstract ID: 29696)

Marine environmental stressors affecting coral reef ecosystems are numerous: from local contaminants (e.g. land-based pollutants) to global stressors (e.g. increase of temperature, ocean acidification). Some are already well known to impact reef organisms whereas others are about to represent a major concern. Although there are many complex biogeochemical interactions and still a large amount of uncertainties of their combined effects, there is an increasing need to investigate the effects of multiple stressors on coral reefs, one of the richest and most diverse ecosystems. An experimental approach (controlled conditions) presents a series of advantages for such investigation since it allows to gradually understand the effects of stressors on marine organism, one by one and combined. This approach, associated with the use of radiotracers appears to be a unique tool to understand the fate of contaminants and furthermore to clue some physiological reactions to counteract stressors (e.g. delineation of contamination pathways, identification of potential bioindicator reef species or illustration of key detoxification compartment in tropical organisms). Current methodological developments are made to allow studying multi-stressors effects on coral reef organisms at different organizational levels (from the cells to the individuals). This talk presents the perspectives of assessing the effects of multiples stressors on reef organisms by using radiotracers, especially in the context of the future changing environment and will be illustrated through a series of experiments.

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GENETIC LINKAGE MAPS ENABLE FUNCTIONAL GENOMICS STUDIES OF CORAL THERMAL TOLERANCE (Abstract ID: 29731)

Modern sequencing technologies have led to an explosion of studies aiming to identify the genomic basis for phenotypic variation. These approaches have been very successful in model systems where the positions of genetic markers can be readily compared, associating genomic regions and genes with phenotypes, but have remained challenging in non-model systems because of limited genomic resources. Here we demonstrate the value of genetic linkage maps for studying the genomic basis of thermal tolerance in reef-building corals. We present a linkage map developed from 2bRAD genotyping of *Orbicella faveolata*, a threatened Caribbean coral. We also genotyped adult coral colonies and measured the bleaching response of each in a controlled thermal stress experiment. The linkage map provided a framework for identifying several genomic regions associated with thermal tolerance, and comparisons with the draft genome assembly are providing insights into biological processes underlying thermal tolerance phenotypes. We also describe a linkage map we are developing for *Platygyra daedalea*, using larvae produced by crossing colonies from the thermally extreme Arabian Gulf. Larval families produced from different colonies show striking differences in thermal tolerance, and we are using the linkage map to identify genomic regions underlying these differences by testing for associations between allele frequency and thermal tolerance. Together, these studies highlight the potential of linkage mapping for functional genomic studies of thermal tolerance in corals.

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MICROBE-MICROBE INTERACTIONS IN THE ESTABLISHMENT OF BLACK BAND DISEASE (Abstract ID: 27880)

Coral diseases are often associated with the appearance of polymicrobial disease consortia that replace stable commensal microbiota. The polymicrobial disease consortium of Black Band Disease (BBD) is dominated by filamentous cyanobacteria of the genus Roseofilum. The recent application of high-throughput sequencing has demonstrated that BBD is highly localized and in as little as 10 cm from the leading edge of the black band layer, the microbial community in the surface mucus layer is indistinguishable from that of healthy corals. Deep sequencing has also uncovered that Roseofilum is a rare but ubiquitous member of healthy Caribbean coral microbiota, implying that the growth of Roseofilum and other members of the disease consortium is constrained in healthy tissue until these undefined restrictions are removed. Here, we present the metagenomic analysis of BBD samples from Florida, Belize, and Guam. We assembled 26 draft genomes from the metagenomes, including five genomes of Roseofilum, nine genomes of Proteobacteria, and twelve genomes of Bacteroidetes. The draft genomes suggest that Roseofilum may be a net source of organic carbon, amino acids and/or vitamins for the heterotrophic bacterial associates in the black band consortium, as well as a source of novel natural products that may influence interactions between microbes.

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LONG-TERM MONITORING REVEALS COMPLEX SPAWNING IN HIGH-LATITUDE ACROPORA SPP. (Abstract ID: 29151 | Poster ID: 175)

Acropora spp. reproductive patterns have been well-documented in reefs from tropical and sub-tropical areas and has shown a synchronous pattern in the gamete release. However, there are few observations from high-latitude locations. Acropora species diversity and spawning patterns in, Nishidomari (32°N), Otsuki, Kochi, Japan differ from those in major coral reef areas in GBR, Australia and Okinawa, Japan where species diversity is relatively high. Most of Acropora species at high latitude are less synchronous and are not associated with a particular lunar phase when compared to corals in the reefal area. Here, we document the reproductive pattern of Acropora species at Nishidomari from early to late summer in 2005 to 2015 in situ. Spawning of 16 Acropora species were observed, starting from the middle of June to the beginning of September. The major spawning day of Acropora spp. in Nishidomari ranged from 5 days after full moon to 5 days after New moon in 2005 to 2015. However, from our records through 11 years, Acropora spp. spawned not only during the major spawning period from 5 days after full moon to 5 days after New moon but also all other lunar phases. These spawning patterns suggest that Acropora spp. at high latitude may have an ability to spawn at every lunar phase.

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BIODIVERSITY ESTIMATION FROM INDIVIDUAL SAMPLES AND METABARCODED COMMUNITY SAMPLES (Abstract ID: 28851)

Documenting marine diversity is challenging because most species are rare, many habitats are difficult to sample, and sampling techniques provide a lot of material that is time consuming to sort through. Accurate and efficient methods to evaluate biodiversity are particularly crucial when sampling remote areas where time in the field is limited,

and historical knowledge sparse. In more accessible locations, having efficient methods to evaluate biodiversity could facilitate monitoring of biodiversity. Metabarcoding, the high-throughput parallel sequencing of DNA barcodes in whole community samples, is emerging as a powerful method to provide biodiversity estimates, as standardized, quantitative samples can easily be compared across space and time. Here, we report how biodiversity estimates from the fauna associated with dead coral heads, and in plankton tows, vary among the Southern Line Islands and the Phoenix Islands. In particular, we evaluate how diversity estimates correlate and complement each others, between individually sampled, visually identified, DNA barcoded animals (> 2mm), and metabarcoded community samples (fractions between 2mm and 500µm, < 500µm, and plankton tows). We also explore how these community level data can be used to gain insights into the unraveling of biogeographic patterns across taxonomic groups.

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## EVALUATION OF THE SOCIO-ECONOMIC BENEFITS AND ROLE OF STAKEHOLDERS IN STRENGTHENING THE MARINE PROTECTED AREA NETWORKS OF SELECTED SITES IN THE PHILIPPINES (Abstract ID: 29328)

Various studies on marine protected area networks have focused on its managerial and biophysical aspect. However, the segmentation of stakeholders and the local communities and the understanding and application of information on the value of the socioeconomic features is crucial in enhancing their performance. This study aims to assess the pivotal functions of each stakeholder groups within the Batangas, Oriental Mindoro and Lanuza Bay Networks. Determination of the relative contribution of their socioeconomic benefits was used to analyze the stakeholders' performance and classify tasks, responsibilities, capacity potentials and limitations of accountable members. The socioeconomic assessment tool and network effectiveness assessment tool accompanied by secondary data collection were used to examine the socioeconomic and general network diffusion of information of the three sites. Local government units possessed the most crucial role in the network acting as direct influence to civil society. The socioeconomic evaluation suggested that the output indicators were associated with the input indicators such as budget and revenue allocation. Moreover, stronger network yields better performances on the identified network management criteria. This indicates that the communication and feedback of socioeconomic benefits with clear stakeholders' functions generally strengthen the marine protected area network. The vitality of network connectivity studies at the municipal-scale scenario highlights the bottom-up approach in contributing to the goals for sustainable development.

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## FISHERIES COMPLIANCE AND MPA EFFECTIVENESS: AN INVESTIGATION IN THE VERDE ISLAND PASSAGE, PHILIPPINES (Abstract ID: 29291)

Marine Protected Areas (MPAs) are used globally as a conservation tool in response to anthropogenic impacts. Compliance of local stakeholders and fishing communities as resource managers contributes to MPA success; however, there is a variety of factors that influence its effectiveness. This study investigates the relationship between MPA effectiveness and compliance defined as the observance to the rules and regulations of the fisher populations including significant variables that contribute to their defiance within the municipalities of Calatagan and Tingloy, Batangas. Moreover, a proposed regulatory framework is presented for validation by the local community in order to enhance stakeholder compliance. The use of the MPA Effectiveness Assessment Tool (MEAT) and key informant interviews provided insights on MPA management effectiveness, socio-economic benefits and other related information for compliance. MPAs in Calatagan had a higher level (3 and 4) of effectiveness compared to Tingloy (level 0); yet compliance between the two MPAs did not vary substantially as both municipalities displayed a similar percentage of violators (<10% of the population fished inside the sanctuaries). However, reduction of other illegal fishing activities was still observed since the establishment of MPAs. Continuous and collective efforts in capacity building, planning, policy, conservation and management strategies among the stakeholders and coastal populations should be addressed to maximize conservation and socio-economic benefits derived from MPAs.

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## HIGHER LEVEL SYSTEMATICS OF THE WALKING, SWIMMING, AND BURROWING HOLOTHUROIDEA (ECHINODERMATA): A SIX-GENE MOLECULAR PHYLOGENETIC APPROACH (Abstract ID: 28518)

Sea cucumbers (Holothuroidea) are some of the most morphologically diverse, ecologically important, and economically valued echinoderms; however, the higher-level systematics of the class remains controversial. Here, we present a phylogeny of the extant Holothuroidea estimated with maximum parsimony, maximum-likelihood, and Bayesian approaches using approximately 5.1 kb of mt- (COI, 16s, 12s) and nDNA (H3, 18s, 28s) sequences from 80 holothuroid terminals representing 23 of the 27 families. We found that three of five orders are non-monophyletic. Apodida is sister to the rest of Holothuroidea. Apodida and Elasipodida lack respiratory trees and lie paraphyletic below a clade with respiratory trees. Elasipodida is polyphyletic. Aspidochirotida is paraphyletic with representatives from three orders (Molpadida, Dendrochirotida, and Elasipodida in part) nested within it. Dactylochirotida is at least in part of derived dendrochirotes. Molpadida's position is least certain; it unstably groups with Dendrochirotida or two other mixed clades that are dominated by members of Aspidochirotida. These results indicate that there has been rampant homoplasy in the anatomical features used as traditional taxonomic characters, necessitating a major systematic revision of Holothuroidea and a new perspective on the evolution of the class.

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## SEAGRASS AMELIORATES CORAL PHYSIOLOGICAL PERFORMANCE UNDER OA CONDITIONS (Abstract ID: 29520 | Poster ID: 374)

Coral reefs are the most biologically diverse and economically important ecosystem on the planet; however they are sensitive to impacts from human activities like ocean acidification. Ocean acidification lowers the saturation state of calcium carbonate utilized by calcifying organisms, potentially leading to dissolution of skeletons and reduced ability to form new calcium carbonate structures, as well as impacting general health and physiology. Seagrass meadows, sometimes found adjacent to coral reefs in the Florida Keys, are mostly net autotrophic as a carbon sink and use the excess bicarbonate for growth. This presents the possibility of locally mediating ocean acidification effects on corals downstream of seagrass meadows. This study tested the impacts of the presence of seagrass (*Halodule wrightii* and*Syringodium filiforme*) on carbonate chemistry and coral health (*Acropora cervicornis*, *Porites porites*, and *Porites astreoides*) in ocean acidification

scenarios expected to occur in this century and present day conditions in land-based experimental settings. Physiological and functional responses measured include chlorophyll *a*, total protein, zooxanthellae counts, photosynthesis, respiration, and net calcification. Physiological responses were variable among species; however, coral respiration was consistently higher in the presence of seagrass. Results presented here describe the potential for seagrass to buffer against negative effects from OA.

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MANIPULATION OF THE ASSOCIATED MICROBIAL COMMUNITY BY THE CORAL HOST IN THE ACROPORA MILLEPORA HOLOBIONT (Abstract ID: 27917)

Corals live in close association with complex and diverse bacterial communities, but little is known about the roles of the bacteria in the diseased and healthy states of corals. Some bacteria are thought to play important roles in coral nutrition and shifts in the abundance of specific bacteria that are normal associates of corals may underlie some coral diseases. Many organisms manipulate their associated bacterial communities by producing anti-microbial peptides (AMPs), and this is also the case in corals. We have identified a novel family of AMPs in anthozoan cnidarians and shown that the Acropora protein is highly active, particularly against gram-positive bacteria. The Acropora AMP is expressed in larvae and all later developmental stages. As gram-negative bacteria dominate the microbial communities associated with "healthy" corals, the novel AMP presumably functions in limiting the growth of gram-positive bacteria. Immune challenge experiments imply that corals are also capable of interfering with bacterial communication systems, potentially providing another means by which control can be imposed on the resident bacterial communities.

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A 25-YEAR MONITORING PROGRAM REVEALS SIGNIFICANT DECREASES IN CORAL BUT INCREASES IN REEF FISH ABUNDANCE AND BIOMASS ON REEFS IN ST. JOHN, US VIRGIN ISLANDS (Abstract ID: 29619 | Poster ID: 573)

Analysis from a 25-year annual fish and benthic monitoring program at 4 sites in St. John, US Virgin Islands (3 sites in Virgin Islands National Park), revealed that despite significant declines in coral cover (>60%, $p<0.05$) primarily from hurricanes, coral bleaching and disease, reef fish abundance and biomass have increased significantly. Permanent benthic transects sampled from 1989 to 2014 revealed significant declines in coral cover, but increases in gorgonian and crustose coralline algae. Macroalgal cover varied over this period. Total reef fish biomass increased across all sites pooled ($p<0.05$), although no significant trends were observed in species richness or abundance. Herbivore increases were primarily driven by parrotfishes (Scaridae) the family with the highest biomass and second highest abundance, for both metrics increased at all sites pooled and individually ($p<0.05$). Secondary consumers increased in abundance and biomass at three sites ($p<0.05$), and biomass increase at all sites pooled was driven by increases of snappers (Lutjanidae) and grunts (Haemulidae). Large predators (primarily piscivores) showed no change in abundance at all sites pooled, but increased at one site in abundance and biomass. Grouper (Serranidae) and jack (Carangidae) biomass increased at all sites pooled and individually (except groupers at one site). The use of standardized monitoring co-located at permanent reef locations over multiple decades provides managers in Virgin Islands National Park and the Caribbean with long term trends in these valuable reef resources.

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IMPROVING ESTIMATES OF LARVAL PRODUCTION, SURVIVORSHIP, AND COMPETENCY IN TWO IMPERILIED CARIBBEAN BROADCASTERS (Abstract ID: 27893)

Knowledge of coral early life-history (e.g., fertilization, pelagic larval duration, survivorship or competency curves) is based largely on laboratory observations and presumptions. We present recent data on two Caribbean keystone broadcasting corals, Acropora palmata and Orbicella faveolata, from the Florida Keys. Pairwise fertilization rates and larval survivorship and settlement/competency curves were determined over their full pelagic duration. For both species, known parental genets that spawn on the same night show dramatic variation in pairwise fertilization assays at high sperm concentration. This implies substantially lower larval production than would be presumed from simple spawning output at a given parental density. Larval survivorship and competency curves were substantially different between species. Peak settlement response (in the presence of positive cue) was observed at day 8-9 after spawning for A. palmata, at which time approximately 75% of fertilized embryos survive. In contrast, O. faveolata has a much less entrained competency curve. Settlement response (with positive cue) is well-developed earlier, by day 4-5, although only 50-60% of fertilized O. faveolata embryos survive at this time. O. faveolata settlement response persists at a similar rate for up to 48 days. Although additional data is needed from other areas/populations, contrasting early life history characteristics suggest strong differences in potential connectivity between these imperiled keystone species and need to be considered in management and recovery planning.

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SHOULD I STAY OR SHOULD I GO? PHENOTYPIC AND ENVIRONMENTAL DETERMINANTS OF LARVAL DISPERSAL (Abstract ID: 28464)

Environmental changes have caused the destabilization of many of the world's ecosystems. In order to cope with environmental change, organisms may adapt by selection or adjust their phenotypes. Organisms may alter the dispersive potential of their offspring to track the movement of favorable environments in space and time. Different dispersal strategies are widespread in animals and plants, enabling species to respond to environmental change. However, despite extreme temporal and spatial variability in coral reef environments, phenotypic plasticity associated with dispersal is virtually unknown among coral reef organisms. We will present the latest findings of our project, ANR funded research co-written with Glenn on his arrival at CRIOBE in Perpignan, which uses clownfish as a model species to unravel the causal mechanisms underlying dispersal. We will present the effects of anthropogenic and environmental stressors on parental behaviour and stress hormone levels, and their impacts on spawning frequency, fecundity and larval traits associated with dispersal.
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REEF FLAT RECOVERY FOLLOWING LARGE-SCALE REMOVAL OF INVASIVE ALGAE (Abstract ID: 29060 | Poster ID: 475)

The invasive alien alga (IAA) *Avrainvillea amadelpha* has fundamentally altered the shallow reef flats of Maunalua Bay, Hawaii, transforming a diverse, productive mosaic of native algal and seagrass communities into a sediment-laden monoculture of alien algae. Between March 2010 and May 2011 the local community and The Nature Conservancy, along with government, academic, and conservation partners, removed 10.9 ha and over 1.3 million kg of invasive algae. Following removal, cover of *A. amadelpha*dropped from 57.9(2.7)% [mean (SEM)] to 5.9 (2.4)%. Silt entrained in the IAA initially remained trapped within the project area, but eventually flushed from the bay following a series of high wave events. For approximately 20 months post-clearance, recovery was on the desired trajectory toward a native-species dominated reef flat community. At 24-months, however, while the majority of the project area remained clear of *A. amadelpha*, significant patches were regrowing and becoming dense in the vicinity of a storm drain that is a source of fine sediment. In response, the community targeted volunteer clearing efforts at these high density areas. After 70 months post-clearance, cover of *A. amadelpha* across the project remains spatially patchy but low (15.5 (1.0)%), while native algae cover has increased from 10.5 (1.8)% post-clearance to 27.8 (1.6)%. Data also suggest that *A. amadelpha* cover has stabilized, indicating that large-scale removal of *A. amadelpha* may be a viable restoration option for reef flat communities in Hawaii.

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NEARSHORE CURRENTS AND POPULATION CONNECTIVITY AROUND OKINAWAN FRINGING REEFS — A DRIFTER STUDY (Abstract ID: 28263)

Ocean circulation processes are one of the major factors that determine connectivity, recruitment, and isolation of populations of reef organisms. It has been demonstrated that ocean models can account for (or match) genetic patterns among populations

inhabiting distant reefs. However, it is not clear whether ocean models can account for year-to-year connectivity at local reef scales, which is essential for optimal management of reef ecosystems. Many regional ocean models have not fully integrated important nearshore ocean processes (e.g., tides, topographically-driven currents, and wave-current interactions). We deployed 182 GPS-equipped surface-drifting buoys (Pacific Gyre, Microstar drifters) near reef crests (typically ~100 m offshore) of fringing reefs in Okinawa Prefecture. Drifter dispersal trajectories were compared with known recruitment patterns of*acroporid* corals and predatory crown-of-thorns starfish, *Acanthaster planci*, along the Onna village coast of Okinawa Island, as well as dispersal probabilities predicted based upon high-resolution (200 m) regional ocean circulation models. Drifting buoys were typically released monthly or bi-monthly in Spring, Summer, and Fall of 2011–2015 from 5 islands (Okinawa, Zamami, Kume, Ishigaki, and Daito). Larger drifter releases were conducted on coral spawning days. Our study suggests that proper inclusion of nearshore circulation processes is important to accurately estimate year-to-year connectivity of corals and populations inhabiting fringing reefs.

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DECIPHERING CELL CYCLE REGULATION IN ZOOXANTHELLAE (Abstract ID: 27794 | Poster ID: 113)

A critical relationship exists between reef-building corals and symbiotic zooxanthellae residing within them. These photosynthetic algae (*Symbiodinium* spp.) harvest energy from sunlight and share it with their coral hosts. In return, corals provide them with metabolites, a stable position in the water column, and protection from grazing. This relationship, which is critically important for reef health, is delicate. Exposure to temperatures only marginally above the average maximum can cause corals to expel their residents. To establish symbiosis, corals produce a signal that forces*Symbiodinium* into a non-motile, dividing state. Other signals then coordinate coral-algal cell divisions to maintain the proper density of symbionts. Evidence suggests that failure of the host to maintain proper control of zooxanthellae cell divisions at high temperatures may cause bleaching. Unfortunately, little is known regarding cell cycle regulation in*Symbiodinium*, so this host-mediated control is poorly understood. Using computational methods, we identified putative cell cycle genes in the recently published genome of *Symbiodinium minutum*. We then correlated expression of these genes with cell cycle phase in cultured *Symbiodinium*. With these data, we will begin deciphering zooxanthelale cell cycle regulation to understand how corals and algae coordinate life cycles to maintain a proper balance for symbiosis.

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CARBONATE CHEMISTRY OF REEFS ALTERED BY MACROALGAE: A SNAPSHOT STUDY OF HOW INVASIVE ALGAE CHANGE THEIR PH ENVIRONMENT (Abstract ID: 29911 | Poster ID: 85)

Non-native macroalgal species have been introduced to Hawaii since the 1950's, and have spread throughout the reefs of the Main Hawaiian Islands. It has been suggested that marine alga are not only resource competitors to reef-building corals, but can also change their local pH environment through photosynthesis and respiration. The resilience of corals is continuously being challenged by climate change, and understanding how coral reefs respond to their changing environment must include looking at how other reef organisms influence their local environments. This study investigated whether invasive algae inhabiting the surfaces of coral reefs could alter the carbonate chemistry environment surrounding reef-building corals. Water samples for pH and total alkalinity (TA) were collected from immediately below algal mats and from the water column on a patch reef in Kaneohe Bay, Hawaii. No relationship was found between percent algal coverage and TA, however, there was a positive correlation between pH and percent algal coverage. These data indicates that macroalgae mats covering coral reefs could be creating distinct pH environments, dissimilar to the surrounding coral reef habitat.

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SEASONAL VARIATION OF THE ANTIOXIDANT ENZYME ACTIVITY IN THE HERMATYPIC CORALS (Abstract ID: 29214 | Poster ID: 125)

Recently an increased frequency of coral bleaching events have been reported in coral reefs around the world. Coral bleaching is caused by stresses such as high temperature, which lead to an increased production of reactive oxygen species. Superoxide dismutases (SOD) are antioxidant enzymes which protects the cell from oxidative stress. Several forms of SOD, harboring different metal co-factors: Cu/Zn, Mn and Fe, are present in animal and vegetal cells including corals and their zooxanthellae. An increase of the amount of SOD enzymes in coral tissue under thermal stress in the field and an increase of total SOD activity in corals experimentally stressed by high water temperature, have been reported. However, literature on natural variations of the different SODs activities in coral is still scarce. The activity of the different SOD for the coral Montipora digitate was monitored for more than a year under natural conditions at the Sesoko Island, Okinawa, Japan. Cu/Zn-SOD and, Mn and/or Fe-SOD activities were assayed by the nitrite method in the host tissue and zooxanthellae. Most of the SOD activities of the coral host and the zooxanthellae showed seasonal variations with increased activities in summer and decreased in winter. During summer, Cu/Zn represented the major contribution to the total SOD activity while in winter it was MnSOD. These results confirm the previously observed variation of amount and activities of SOD in corals under thermal stress. In addition, it shows that the different SODs have different responses against stressors such as high and low temperature.

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40 YEARS OF ENVIRONMENTAL DISTURBANCES AND MOLLUSK COMMUNITIES IN THE INTERTIDAL ZONE OF OKINAWA ISLAND, JAPAN. (Abstract ID: 30059 | Poster ID: 455)

Conservation of biodiversity is an important issue, especially in coral reef ecosystems. On Okinawa Island, Japan, the coastal area has continuously been exposed to artificial disturbances such as landfill, seawall construction, soil run-off, and water pollution. However, how local marine organism communities respond to such long-term disturbances and what factors determine local community structure are hard to assess due to a lack of past environmental and faunal data. In this study, we investigated the presence/absence of mollusk species in the intertidal zone in 2015 at 91 sites located at 5 km intervals along the coastline of Okinawa I., and then compared with unpublished results from 1974. Fourteen sites (=15%) disappeared between 1974 and 2015 due to construction of seawalls, fishery ports, or landfill. For environmental data set, we obtained data on soil run-off, nutrients, and river pollution from Okinawa Prefectural Institute of Health and Environment, geological features from the Geological Survey of Japan, and calculated shore direction and openness to the ocean from Google Earth, along with other values such as distance from shoreline, type of substrate, etc. We then analyzed the influence of geological and physiological environmental factors on mollusk community structure using principal component analyses. Although we are unable to directly compare 2015 data to 1974 data due to differences in survey efforts, comparative analyses will provide us important information in understanding changes in the environment and biodiversity over the last 40 years.

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JUVENILE CORALS ARE AFFECTED BY LOW SEDIMENTATION RATES: THE FIRST WEEKS ARE CRUCIAL (Abstract ID: 28758 | Poster ID: 430)

Increased sedimentation due to anthropogenic activities is a threat to many near-shore coral reefs. The effects on adult corals have been studied extensively and are rather well-known. Studies about the impact of sedimentation on the early life stages of scleractinian corals, however, are rare although recruitment is essential for conserving and restoring resilient coral reefs. Laboratory and in-situ experiments with recruits of different age classes focused on the broadcast-spawning species Acropora hyacinthus, and the brooding coral Leptastrea purpurea. Recruits were exposed to different sediment loads over a time-span of three to five weeks. Applied sediment loads were more than one order of magnitude lower than those known to affect survival of adult coral colonies. The results show that growth and survival of newly settled recruits were negatively affected by sediment loads which had no effect on the growth and survival of one-month old recruits. All experiments indicate that newly settled coral recruits are most sensitive to sedimentation within the first two to four weeks after settlement. The co-occurrence of moderate sedimentation events during and immediately after periods of coral spawning can therefore reduce recruitment success. These findings provide new information to develop comprehensive sediment management plans for the conservation and recovery of coral reefs affected by chronic or acute sedimentation stress.
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ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT FOR LEADERS, EXECUTIVES AND DECISION-MAKERS (LEAD) (Abstract ID: 29074 | Poster ID: 574)

Given the global need for more holistic and balanced fisheries management through an Ecosystem Approach to Fisheries Management (EAFM) and requests from fisheries managers across Southeast Asia to gain support of leadership to implement an EAFM, a consortium of international fisheries management organizations joined forces to develop the "EAFM for Leaders, Executives and Decision-makers (LEAD)" toolkit. The EAFM LEAD toolkit provides leaders in fisheries and other sectors and throughout levels of government with an improved understanding of, and ability to initiate EAFM, and more broadly ecosystem-based fisheries management (EBFM). The LEAD toolkit was designed to help facilitators educate and engage leaders in an EAFM/EBFM so that they will then empower their people to implement an EAFM. By using the appropriate, situation-based tools, the toolkit helps leaders: 1) understand why EAFM leads to more sustainable fisheries management and can improve the well-being of their people; 2) understand what an EAFM is; 3) recognize and discuss human, ecological, and governance issues and concerns relating to their fisheries and how an EAFM can help; 4) understand in general how the EAFM Planning Process works; 5) recognize that they have the legal and institutional ability to engage in an EAFM; 6) communicate EAFM across sectors and throughout levels of government; and 7) understand the need for developing capacity and taking steps toward the implementation of an EAFM.
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STATUS OF CORAL REEFS IN SRI LANKA: A MICROBIAL PERSPECTIVE (Abstract ID: 27946 | Poster ID: 148)

Coral reefs have suffered from a range of impacts from local anthropogenic influence to global climate change. These changes adversely affected to switch coral dominated reefs systems to algae dominated systems. However the mechanisms related to these global changes in coral reefs is not well understood to date. We hypothesis that microbial activity in reef waters could be a possible lower scale indication to explain mechanisms related to global change in coral reefs. Reef benthic monitoring, water chemistry (Dissolved Organic Carbon - DOC) and higher Dissolved Inorganic Nitrogen - DIN) and abundance of microorganisms (Bacteria and Virus) performed 08 coral reef sites around Sri Lanka from February 2014 to April 2015. Results show that the coral reefs in north are dominated by living corals whereas reefs in south dominated by algae. Algal dominant reefs represented by higher microbial abundances with relation to lower concentrations of DOC and higher DIN. These results suggest that potential connectivity to changes of reef systems with the microbial activity. Further analyses are in progress to explain how microbes structuring reef in Sri Lanka

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MOLECULAR MECHANISMS UNDERLYING ESTABLISHMENT OF CORAL-SYMBIODINIUM SYMBIOSIS: A TRANSCRIPTOMIC APPROACH (Abstract ID: 27923)

Despite the ecological significance of coral-Symbiodinium symbiosis, very little is known about the molecular mechanisms involved in the establishment of the relationship. Gene expression studies based on microarrays have led to the assumption that host transcriptome is largely unresponsive during the establishment of symbiosis with competent Symbiodinium. In the present study, Illumina RNA-Seq was used to investigate transcriptome changes in Acropora digitifera larvae during exposure to competent Symbiodinium (a clade B strain). A transient period of differential expression involving a small number of genes (1073 transcripts; <3% of the transcriptome) was detected very early in the infection process i.e. 4h after infection. This phenomenon has not previously been detected as a consequence of both the lower sensitivity of the microarray approaches used and the sampling times used. The transcriptome data imply that translation and oxidative metabolism are supressed in the coral host during the infection process, and altered expression of some apoptosis-related genes was also observed. The results also suggest the involvement of both partners in the establishment of the symbiosis; there is an active response on the part of the host in recognizing the symbiotic partner, but an apparent suppression of host immune responses may be initiated by the symbiont. The results are also consistent with the hypothesis that the symbiosome is a phagosome that has undergone early arrest, raising the possibility of a common mechanism of symbiont infection in corals and symbiotic sea anemones.

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HOME RANGE, ACTIVITY PATTERNS AND INDIVIDUAL HABITAT TRANSITIONS OF DUSKY PARROTFISH SCARUS NIGER ON INTACT AND TYPHOON-IMPACTED CORAL REEFS (Abstract ID: 29359 | Poster ID: 516)

Parrotfishes mediate competition between corals and macroalgae, and their role in algal removal will be influenced by changes in movement patterns on reefs in different states. Acoustic telemetry was used to understand movement of Dusky parrotfish Scarus niger at Apo Island, Philippines. We established an array of acoustic receivers on the south-eastern side of Apo where coral cover was very low (5%) due to severe damage caused by two typhoons (in 2011 and 2012). Another array of receivers was established on the opposite side of the island where the reef was intact (60% coral cover). Ten S. niger were captured, tagged and released on each side of the island. Data was available from 17 out of the 20 tagged S. niger. Fourteen fish yielded longer-term data (2–3 months). Individuals with home ranges in typhoon-impacted habitat visited intact habitat on the opposite side of the island, and vice versa. Most fish remained on their respective side of the island and displayed activity spaces that were usually smaller than receiver arrays (400 m wide). Depth data was used to examine individual activity by calculating daily metrics for vertical migration, mean depth and standard deviation of depth. Activity patterns were similar in both habitats, with larger mean depth in intact habitat, and more vertical activity in larger fish. Daily movements of parrotfish observed over the long term ranged from a few 10s to several 100s of m. The longer-range movements indicate that some individuals may be able to adjust their home range and activity patterns in response to large-scale changes in the benthos that may influence grazing patterns.

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BIOGEOGRAPHIC ASSESSMENTS: A FRAMEWORK FOR INFORMATION SYNTHESIS IN THE MANAGEMENT OF CORAL REEF ECOSYSTEMS (Abstract ID: 29589)

This paper presents NOAA's Biogeographic Assessment Framework (BAF), a decision support process for ecological forecasting and environmental management with emphasis on the spatial management of resources in coral reef ecosystems. Spatial planning is a considerable challenge for marine stewardship agencies because of the need to synthesize and model information on complex socio-ecological patterns across geographically broad spatial scales. The BAF provides a multi-disciplinary approach to integrate geospatial information into formats and visualization tools readily useable for marine resource management. The BAF is comprised of four components: (1) Planning; (2) Data Evaluation; (3) Ecosystem Characterization; and (4) Management Applications. Regardless of the approach taken to fill data gaps, errors in the source data or errors accumulated during processing can proliferate during data synthesis that generate complex spatial patterns of uncertainty. To aid managers in understanding data reliability, BAF

quantifies and documents errors and uncertainties throughout project development. Three major sources of uncertainty in the BAF are: (1) measurement or observation error, (2) errors arising from assumptions and approximations made in the statistical modeling process, and (3) inherent variability in ecological processes. Through applied case studies this paper presents the structure of the BAF framework and the associated analytical techniques applied to management information needs.
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STUDIES ON EFFECT OF CLIMATIC CHANGES ON SCLERACTINIAN CORALS THROUGH LONG TERM PERMANENT MONITORING PLOTS IN ANDAMAN AND NICOBAR ISLANDS (Abstract ID: 27961)

A total of 579 species of scleractinian corals under 94 genera and 19 families with 127 threatened species under IUCN were recorded from extensive 1962 km. coastline and adjoining continental shelf region of Andaman and Nicobar Islands against the India's data base of 611 species belong to 98 genera and 19 families. To assess the status of corals in A&N Islands, 10 Long Term Permanent Monitoring Plots (LTPMPs) have been established with an area of 100 sq. m. per plot since 2009. The data on inter- and intra-species cohesion and the adaptive features for the acquisition of development in association with ecological parameters and associated faunal communities are being collected in a regular interval.A total of 254 species of scleractinian corals under 50 genera and 12 families were recorded from 10 LTPMPs areas. The mean live coral cover was 57.65±5.99% with mean density of 22.98±2.65 colony/10 sq. m. was recorded during 2009. Due to rise of abrupt Sea Surface Temperature (SST) about 3.7°C against the normal average temperature, massive bleaching was recorded throughout Andaman Sea during April-May 2010 and resulted with 86.94±6.27% of bleaching exclusively in the LTPMPs. The resilience of scleractinian corals against bleaching was recorded during 2011 due to conducive environment and it recovered to the extent of 21.40±13.87% followed by recruitment of new colonies or coralla of scleractinian corals with the mean of 18.6±8.85%. LTPMPs of South Andaman region faced maximum stresses during the climatic alteration followed by Middle and North Andaman region and Nicobar group.

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INTEGRATING TRADITIONAL CUSTOMARY LAW, KNOWLEDGE AND PRACTICE WITH CONSERVATION IN THE BIRDSHEAD SEASCAPE, THE HEART OF THE CORAL TRIANGLE, INDONESIA (Abstract ID: 30001)

As the world's largest archipelagic nation and custodian of 18 percent of the world's coral reef area, Indonesia has made huge strides in creating a national system of nearly 37 million acres of marine protected areas during the past two decades. But enforcement in these reserves is not always effective, and illegal fishing continues. To address this problem in the Raja Ampat Archipelago in the West Papua province of Indonesia, teams of citizens actively patrol the area, working to decrease illegal fishing. However, the legal basis for enforcement by communities is unclear: many of these communities follow a system of "adat" law, the set of largely unwritten, cultural customs and practices dating to the 15th century that have under-pinned management of marine resources. These customs and laws have not previously been consistent and integrated with national level legislation. Two key approaches are being used to address these challenges: i. documenting the customary laws and then developing a policy framework for their legal application and enforcement by communities; ii. building a targeted team and road map for stakeholder engagement in the formal codification and strengthening of adat law on marine resource management. We are already seeing strong support and commitment at the grass-roots and regional government levels, with presumed benefits for marine resources and ecosystems.

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THE EXPOSURE OF THE GREAT BARRIER REEF TO OCEAN ACIDIFICATION (Abstract ID: 29104)

The Great Barrier Reef is founded on reef-building corals. Corals build their exoskeleton with aragonite, but ocean acidification is lowering the aragonite saturation state of seawater (Ωa). The downscaling of ocean acidification projections from global to GBR scales requires the set of regional drivers controlling Ωa to be resolved. Here, we use a regional coupled circulation–biogeochemical model and observations4, to estimate the Ωa experienced by the 3,581 reefs of the GBR, and to apportion the contributions of the hydrological cycle, regional hydrodynamics and metabolism on Ωa variability. We find more detail, and a greater range (1.43), than previously-compiled coarse maps of Ωa of the region (0.4), or in observations (1.0). Most of the variability in Ωa is due to processes upstream of the reef in question. As a result, future decline in Ωa is likely to be steeper on the GBR than currently projected by the IPCC assessment report.

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GENETIC DIFFERENTIATION OF THE CORALS STYLOPHORA PISTILLATA AND POCILLOPORA VERRUCOSA ACROSS MULTIPLE SPATIAL SCALES IN THE RED SEA (Abstract ID: 29272)

Observing populations at different spatial scales gives greater insight into the specific processes driving genetic differentiation and population structure. Here we assessed connectivity across multiple spatial scales in the Red Sea to determine the population structures of two reef building corals Stylophora pistillata and Pocillopora verrucosa. The Red sea is a 2,250 km long body of water with extremely variable latitudinal environmental gradients, where genetic isolation by environment and distance has previously been found in other organisms. Mitochondrial and microsatellite markers were used to determine lineages and to look for genetic differentiation among sampling sites. No distinctive population structure across the latitudinal gradient was discovered for P. verrucosa, suggesting a phenotypic plasticity to various environments. This is corroborated by a lack of genetic differentiation at a fine scale. S. pistillata displayed a heterogeneous distribution of three distinct genetic populations on both a fine and a large scale. Fst, Gst, and Dest were all significant (p-value<0.05) and showed moderate genetic differentiation between all sampling sites. However, this seems to be a byproduct of the heterogeneous distribution, as no distinct genetic population breaks were found at the large scale. Greater population structure was found on a fine scale for S. pistillata suggesting genetic selection based on fine scale environmental variations. However, further environmental and oceanographic data is needed to make more inferences on this structure at small spatial scales.

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THE ROLE OF THE SCLERACTINIAN-ASSOCIATED HYDROZOANS IN THE CORAL COLONY HEALTH STATE (Abstract ID: 28343)

Scleractinian reef corals have been acknowledged as the most numerous host group for associated hydrozoans belonging to the genus *Zanclea*. However, the benefits and costs of this symbiosis are still not clear. Although trophic and/or protection mutualism seems a plausible explanation of the association, a possible relationship between the occurrence of hydrozoans and coral diseases has also been proposed. The objective of this study is to test if *Zanclea* hydrozoans significantly influence the health of the reef-building corals. To do that, we test the relationship between the occurrence of *Zanclea* hydrozoans on corals in relation to different colony conditions: healthy, stressed (bleaching, algae overgrowth, fishes and gastropods feeding scars), and diseased (WS, SEB, BrB, BBD). Our preliminary field surveys revealed as the association is widespread in the coral communities of Maldives and Red Sea. A total of 29 scleractinian genera were found in association with *Zanclea* hydrozoans. The overall *Zanclea*-scleractinians prevalence resulted very low in the coral reefs, but significant differences were observed between scleractinian genera and coral communities. Furthermore, no positive implications were found for both diseased and stressed corals, although a positive effect against predation (fish bites) was observed for scleractinians hosting *Zanclea*. In conclusion, the potential implications of the hydrozoan–scleractinian symbiosis for coral health, its wide distribution, and the number of species it involves indicate urgent need for further investigations.

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THE DEVELOPMENT AND IMPLEMENTATION OF MARINE HABITAT MAPPING TOOLS AS A MECHANISM TO ENCOURAGE IMPACT AVOIDANCE AND MINIMIZATION TO CORAL REEF RESOURCES (Abstract ID: 29284)

Planned water development projects can provide vital infrastructure to the public. However, these projects can have significant impacts to coral reef resources. Under the Environmental Protection Agency and U.S. Army Corps of Engineers' 2008 rule for Compensatory Mitigation for the Losses of Aquatic Resources as well as the mitigation policy for the U.S. Fish and Wildlife Service, the avoidance and minimization of impacts to resources is required prior to compensatory mitigation for the permanent loss of resources. Prior to finalizing the project design, information such as the type, abundance, and distribution of resources within and nearby a proposed project can be valuable in determining project alternatives. The development of acceptable project alternatives provides maximum avoidance and minimization benefits. Obtaining this information in a rapid and spatially explicit manner can be a cost effective method that can help provide balance between development and resource protection. Historically, tools to provide this basic information within a specific project area have been lacking, limited in utility, and/or expensive. Here, I describe a process and suite of tools that produce standard map products with data on all major groups of coral reef organisms and their relative abundance. The process includes using standard field protocols, terminology, data entry with quality control, data processing, and final map production. This standardized process produces maps in a rapid and cost effective manner that is comparable across projects and geographic regions.

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A NETWORK APPROACH TO IDENTIFY SUCCESS AND GAPS IN CORAL DISEASE SCIENCE OVER FIVE DECADES OF RESEARCH (Abstract ID: 28165 | Poster ID: 154)

Here we used a network approach to determine the achievements and gaps of coral disease research. For this, two networks were built based on the answer to 5 questions in peer-reviewed coral disease papers published from 1965 to 2015: Which coral genera are being studied? Where was the sampling performed? Does it include temporal or seasonal patterns? What was the aim of the study? Where the institutions involved were based at? We detected 7 communities (i.e, group of nodes) indicating an apparent bias to disease prevalence studies, whereas other fields such as pathology, microbiology and immunology have received attention for few diseases in a limited number of coral genera and sites. The results indicated that the top 5 locations receiving more attention were Australia, USA (Florida Keys), Hawaii, Puerto Rico and Israel. Concomitantly, the leader institutions are based at USA (continental territory), Australia, Hawaii, Puerto Rico and Israel. Also, the analysis showed a 17% of reciprocity between study sites and the institutions participating in the research, and a negative correlation in the association of the institutions and locations (i.e. locations with few studies conducted by leader institutes and vice versa. Furthermore, the network shows that 77% of sites did not include local institutions in half of the papers published. We conclude coral disease science must focus to fill out existing gaps, increase efforts in poorly understood syndromes and to improve the integration of ecological, epidemiological and molecular studies.

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CORAL GARDENING AS A MPA MANAGEMENT TOOL: A SUCCESS STORY IN THE REPUBLIC OF SEYCHELLES (Abstract ID: 29441)

Marine Protected Areas (MPA) promote coral reef recovery, however this is slow and limited in most occasions. Natural and human-made threats continue and MPAs might not be enough to assist in the recovery of coral reefs. More active conservation measures are needed. We used "coral gardening" as an active conservation measure to speed up coral reef conservation in the no-take MPA Cousin Island Special Reserve, Republic of Seychelles. First, we harvested coral fragments from donor colonies or corals of opportunity in nearby areas and reared them in mid-water rope nurseries for about 1 year. Second, we transplanted the nursery-reared corals to a degraded reef site within the MPA. A total of 24,431 corals were transplanted to 0.52 ha of degraded reef site from December 2012 to April 2014. This resulted in a 300% increase in coral cover by the end of the project. We compared the fish and benthic community structures of a degraded control site and the transplanted site before-during-after transplantation. We observed a five-fold increase in fish species richness, a three-fold increase in fish density, and a two-fold increase in coral settlement and recruitment at the transplanted site. We also analysed the costs of transplantation and the life cycle of coral reef restoration technology. Our results support the application of large-scale, science-based coral reef restoration projects with long time scales to assist the recovery of damaged reefs. We propose large-scale coral reef restoration as a cost-effective tool to include in the MPA manager's toolbox.

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EXTREME 2011 LA NIÑA EVENT DRIVES CORAL RANGE EXPANSION ALONG THE WEST AUSTRALIAN COAST (Abstract ID: 28294 | Poster ID: 308)

The concept of range shifting offers a ray of hope for the future of coral reefs that are under increasing threat from climate change. The likelihood of coral range expansion depends upon the availability of source larvae, the presence of suitable, non-degraded habitat and the incidence of favourable ocean currents to transport larvae. For many marine species including corals, pole-ward range expansions have been documented and here we report a new example of climate-driven range expansion along the West Australian (WA) coast. In January 2015, during an island wide survey of coral diversity, a small colony of A. digitifera was observed growing on an exposed intertidal rock platform, at the western tip of Rottnest Island (32˚S). Based on WA and Queensland Museum specimen records the most southerly record of A. digitifera is currently North Island, Houtman Abrolhos (~28˚S), almost 450 km north of Rottnest Island. We estimate the colony (10 cm by 15 cm) to be approximately ~4 years old, based on a temperate water growth rate estimate of <5 cm/year. The coral age suggests settlement occurred during the 2011 unprecedented La Niña event when sea surface temperature (SST) anomalies up to 5˚C above average were recorded along the WA coast and contributed to strengthening the Leeuwin Current. This unusual climatic event coincided with the annual spring coral spawning along the WA coast enabling larvae transportation further south than usual. Although recruitment success appears to have been extremely low, further range expansions may be expected in future extreme La Niña years.

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SPATIAL PATTERNS IN FISHERIES, POPULATION STRUCTURE AND DEMOGRAPHY OF A HEAVILY EXPLOITED CORAL REEF FISH IN THE TROPICAL PACIFIC (Abstract ID: 29821)

Coral reef fish provide a significant source of food and economy of Pacific Island peoples, yet relatively little is known on their life history in the region. Here, spatial patterns in fisheries, connectivity and demography of a heavily exploited lutjanid, *Lutjanus gibbus*, are explored across multiple locations in the tropical Pacific. Creel surveys highlighted the species' importance to artisanal and subsistence fishers in the region, with this single species constituting >30% of total landings by abundance and >25% by weight at certain locations. Preliminary examination of microsatellite markers revealed little genetic variation amongst locations. Demography, in particular age and growth relationships, maximum age and mortality estimates, differed considerably across locations, with latitude (as a proxy for water temperature) and human population density appearing as significant drivers of the observed spatial patterns. Initial results indicate a strong relationship between otolith morphometrics (weight, length, width, thickness) and age estimated from sectioned otoliths, suggesting that these indices may provide a reliable estimate of age in the absence of sufficient resources to section otoliths for age estimation. These results provide critical information for monitoring and management of this key reef fish across its distribution.

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USING THE ENDANGERED SPECIES ACT TO ACHIEVE CORAL CONSERVATION (Abstract ID: 29378)

In 2006, elkhorn coral Acropora palmata and staghorn coral A. cervicornis were listed as threatened species under the U.S. Endangered Species Act (ESA), and in March 2015, NOAA Fisheries adopted a recovery plan for the two coral species. While NOAA Fisheries is mandated to recover these species, we do not have all the resources or authorities to implement all the activities necessary to meet the recovery goals. Thus we must rely upon partnerships to implement recovery actions. However, the ESA does provide several tools, which we have been using since the species we listed to promote recovery. This paper will focus on how the ESA can be used a a tool for coral conservation. We will present several case studies where regulatory and voluntary actions have resulted in conservation.

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CURRENT STATE OF THE CORAL REEF ECOSYSTEMS IN IRANIAN COASTS OF THE PERSIAN GULF: ANTHROPOGENIC EFFECTS AND AN UPDATED CHECK-LIST OF THE SCLERACTINIAN CORALS (Abstract ID: 27849 | Poster ID: 346)

Persian Gulf is regarded as a unique marine ecosystem, from an ecological point, it is dominated by some extreme environmental conditions; air temperature can rise to above 55oC heating up the Gulf water by over 40oC and elevating its salinity to up to 45ppt. Despite such extremes, the Gulf is a vital habitat for thousands of marine creatures, many of which displaying remarkable adaptations to its harsh environment. Numerous studies have been performed on the impacts of human activities on the coral communities of the southern part of the Gulf in Arabian states, but less is known about these impacts in Iranian shores, In this study, we have reviewed the available data to analyze the current situation of the corals in northern Persian Gulf in relation with anthropogenic and natural alterations. While coastal pollution by extended urbanization, petrochemical and fisheries activities in the recent years has negatively affected the coral lives across all coastal lines of the Gulf, compared to the southern part, there has been less an attempt or substantial strategies to protect or restore coral biodiversity in northern Persian Gulf. Nevertheless, the Iranian waters still have a considerable contribution to the world coral diversity by hosting more than 40 species of hard corals which have so far been documented even from, more or less, polluted zones; yet more species are to be discovered. Porites seems to be the most susceptible form being the dominant coral in areas distantly located from human activities, whereas Acropora is frequently found in more disturbed grounds.
https://scholar.google.com.br/citations?user=OCuokBMAAAAJ&hl=en

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STRUCTURAL AND FUNCTIONAL ANALYSIS OF CORAL HYPOXIA INDUCIBLE FACTOR (Abstract ID: 28309)

Oxygen plays a pivotal role in the physiological adaptation of metazoans to a broad range of terrestrial and aquatic environments. It is known that symbiotic cnidarians are submitted to wide, rapid and daily variations of oxygen concentration. Indeed, during daytime, intracellular $O_2$concentrations increase due to the symbiont photosynthetic process, while during night, respiration of both host cells and symbionts leads to intra-tissular hypoxia. It is well established that, in higher eukaryotes, maintenance of oxygen homeostasis and adaptation to hypoxia require HIF that is a heterodimeric transcription factor composed of a &alpha a &beta subunit. Whereas HIF &beta is stable, HIF &alpha is sensitive to oxygen concentration due a specific domain called ODD. Here, we carried out a mechanistic study of the hypoxic response of the model coral Stylophora pistillata. We cloned and characterized the coral HIF &alpha and &beta genes, and determined their expression and physiological regulation. We performed structural and functional analyses by transfecting coral HIF &alpha and HIF &beta in mammalian cells. Our results indicate that coral HIF subunits share functional similarities with human HIFs. Although HIF &alpha has an incomplete ODD domain relative to its human homolog, its protein level is increased under hypoxia when tested in mammalian cells. Furthermore, we tested HIF expression and DNA binding activity in hospite over a diel cycle (dark / light) and in artificial hypoxic conditions.

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EXTENSIVE REEF DEVELOPMENT WITHIN THE "MESOPHOTIC" NEARSHORE GREAT BARRIER REEF: EVIDENCE FOR INTRA-REGIONAL VARIATIONS IN CORAL RESILIENCE (Abstract ID: 27826)

Mean coral cover on Australia's Great Barrier Reef (GBR) has reportedly declined by over 15% during the last 30 years. Climate change events and outbreaks of coral disease have been major drivers of degradation, often exacerbating the stresses caused by localised human activities (e.g. elevated sediment and nutrient inputs). Here, however, in the first assessment of nearshore reef occurrence and ecology across meaningful spatial scales (15.5 sq km), we show that areas of the GBR shelf have exhibited strong intra-regional variability in coral resilience to declining water quality. Specifically, within the highly-turbid "mesophotic" nearshore (<10 m depth) of the central GBR, where terrigenous seafloor sediments are persistently resuspended by wave processes, coral cover averages 38% (twice that reported on mid- and outer-shelf reefs). Of the mapped area, 11% of the seafloor has distinct reef or coral community cover, a density comparable to that measured across the entire GBR shelf (9%). Identified coral taxa (21 genera) exhibited clear depth-stratification corresponding closely to light attenuation and seafloor topography. Reefs have accreted relatively rapidly during the late-Holocene (1.8-3.0 mm/y) with rates of vertical reef growth influenced by intrinsic shifts in coral assemblages associated with reef development. Indeed, these shallow-water reefs may have similar potential as refugia from large-scale disturbance as their deep-water (>30 m) "mesophotic" equivalents, and also provide a basis from which to model future trajectories of reef growth within nearshore areas.

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LABORATORY INDUCED ESTRADIOL EXPOSURE STIMULATES TRANSCRIPTIONAL RESPONSES IN THE SEA ANEMONE EXAIPTASIA PALLIDA (Abstract ID: 28125)

Endocrine disruption is suspected in cnidarians but no direct hormone interactions have been identified. Pathways associated with hormone biosynthesis and signaling are an understudied area in cnidarian biology. Sea anemones (Exaiptasia pallida) were exposed to 20ppb estradiol for 4 hrs. Representational Difference Analysis (RDA) was used to isolate differentially expressed transcripts associated with estradiol exposure. RNA samples were extracted after a 4hr exposure as well as after subsequent recovery periods of 4hrs, 24hrs, 96hrs, and 7days. Quantitative Real-Time PCR quantified the expression of 17β-hydroxysteroid dehydrogenase, Niemann-Pick, Equastatin, C3, Cathepsin, and interleukin-6. These genes are known to be associated with steroid metabolism and transport, immunity, lysosomal proteases/inhibitors, and inflammation. These genes were used to characterize the expression profiles of laboratory induced exposures of estradiol at 20ppb, 2ppb, and 0.2ppb. Post-exposure expression profiles provide insight into how the organism recovers from an acute exposure. These genes were also used to screen for the specificity of response. Other anemones were exposed to 20ppb testosterone or 20ppb cholesterol for 4 hrs. This suite of genes can generate expression profiles capable of differentiating exposures to different sterols.

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AN EXAMINATION OF VARIATION IN BENTHIC MEGAFUANAL COMMUNITY STRUCTURE WITH DEPTH AND SIDE OF A SEAMOUNT (Abstract ID: 30025 | Poster ID: 322)

Increasing evidence suggests that seamounts communities are not homogenous across a given feature, harboring a number of habitats that increase the overall diversity of seamount communities. A number of environmental parameters may influence the distribution of benthic species on seamounts. As part of a larger project to examine the effects of trawling on seamounts, we conducted AUV Sentry photo transects along 3 sides of Pioneer Bank Seamount in the Northwestern Hawaiian Islands. A total of over 90,000m of transects were conducted at depths from 200-700m. Environmental data including depth, substrate type, slope, slope orientation, rugosity, salinity, temperature, and oxygen data were collected simultaneously. We present a preliminary analysis of the benthic megafauna communities present on the seamount and correlate variations in community structure to variations in measured environmental parameters to gain a better understanding of the scale of variability that occurs on a single feature. Our results add further evidence to the growing body of literature that demonstrates the variability found on seamounts. These scales of variability need to be incorporated into science and management plans.

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IMPROVING CORAL RESTORATION THROUGH PRIOR KNOWLEDGE OF ACCLIMATION OR ADAPTATION TO LOCAL ENVIRONMENT: A COMMON GARDEN EXPERIMENT IN A NATURAL BLEACHING EVENT (Abstract ID: 30157)

One of the primary values of understanding climate resilience of naturally growing corals is the opportunity to use this information to enhance the success of future restoration efforts. Here we test if prior knowledge of a coral's experimental heat tolerance or microhabitat allows us to predict colony-level differences in thermal tolerance that are retained in common gardens after transplantation and acclimatization. In American Samoa, we characterized microclimate, acute stress performance and transcriptome response for 80 coral colonies across four species and then transplanted 800 fragments of these corals into a common garden nursery. After a natural bleaching event in 2015, we evaluated how bleaching severity correlated with expectations from prior knowledge and with the observed performance of the original colonies on the reef. After 12 months,

corals with higher stress tolerance or from warmer microhabitats bleached less and survived better than conspecifics with lower stress tolerance from cooler microhabitats. Knowledge of microhabitat structure or variation in acute stress tolerance could provide tools for active management to protect and restore reefs before the worst impacts of climate change.

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THE META-GOVERNANCE OF CORAL REEFS (Abstract ID: 28029)

Over the last two decades of environmental governance scholarship, the traditional conceptualisation of resource governance (as undertaken by top-down governments) has given way to a more networked understanding of resource governance (involving a variety of public and private actors). The devolution of governance to lower orders of government (decentralised governance) was based on the understanding that government functions more responsively and effectively at local levels. The delegation of policy decisions to individual resource users (privatised governance) was based on the understanding that private actors supplement governmental capacity and authority. The coordination of actors at this level (networked governance) was based on the understanding that involving a wide range of actors enhances the certainty and legitimacy of governing. Yet, despite the magnitude of these reforms, and their significance for efficiency, accountability and efficacy, there has been very little academic consideration of how these new arrangements work beyond an acknowledgment of the new complexities of governing. This paper examines the role and tools of the state, and other 'metagovernors', in organizing both the conditions for effective network governance, and the broader enabling fiscal, administrative and democratic pre-conditions. It seeks to cut through the dominant discourse on governance complexity and explore the transformations necessary to avert governance failure and achieve environmental sustainability.

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DIAZOTROPH DIVERSITY AND THEIR POTENTIAL ROLE AS CORE MEMBERS OF THE CORAL HOLOBIONT (Abstract ID: 27988)

Corals thrive in nitrogen (N) limited habitats and have therefore acquired a number of strategies to derive N from organic (e.g. heterotrophic feeding) and inorganic sources. Diazotrophs, defined as bacteria and archaea capable of fixing nitrogen, can supplement the coral holobiont with N in the form of ammonia (NH3). Diverse diazotroph assemblages have been found in a limited number of coral species, in both adult and larval life stages. Thus further investigation is needed to elucidate the ubiquity of diazotrophs as part of the core coral microbiome, and their role in contributing essential N products to both the coral host and Symbiodinium. The current study utilized gene-targeted Illumina sequencing coupled with rates of 15N2 uptake and translocation within the holobiont to illuminate the extent of ongoing N2 fixation within six coral species on the Great Barrier Reef, Australia. Coral samples were collected from 15-18 m near Heron Island Research Station and amplified using primer sets that target both the nitrogenase gene (i.e. nifH) and the universal bacterial/archaeal 16S rRNA gene. The microbial community associated with one coral species (Stylophora pistillata) will be further interpreted in the context of concurrent measurements of 15N2 fixation rates. Results provide expanded insight into the taxonomic diversity of coral-associated diazotrophs as well as the potential for N2-fixation within a set of globally important coral species.

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SCIENCE FOR STAKEHOLDERS IN MPA DEVELOPMENT AND MANAGEMENT (Abstract ID: 28394)

Florida Keys National Marine Sanctuary (FKNMS) is undergoing its first comprehensive review of its network of marine zones and regulations. This review is founded upon addressing the status and trends identified in its 2011 Condition Report which documented more than a century of pressures, including a history of discharges, coastal development, habitat loss, and over exploitation of large fish and keystone species. The report details how human actions — such as poaching, vessel groundings and discharging of marine debris — continue to negatively affect the habitat and living resources of the sanctuary, but that resource condition may be improved with long term management efforts, regulatory compliance and community involvement. Since 2012, the National Oceanic and Atmospheric Administration has been working with the Florida Keys National Marine Sanctuary's Advisory Council – made up of more than 50 members of the Florida Keys marine community and government agencies – to set goals, objectives, and then identify potential programmatic, regulatory, and zoning changes based on the research and monitoring conducted in FKNMS over the last 25 years. This presentation will examine the use and digestion of scientific findings by the public, community advisory council, and issue specific working groups in decision-making and consensus building during the 2013 & 2014 FKNMS stakeholder process. The presentation will also explore opportunities for use in other communities and applicability to other processes - past, present and future.
http://floridakeys.noaa.gov/review/welcome.html

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QUANTITATIVE ASSESSMENT OF THE IMPACT OF NOISE IN A SPACEBORNE HYPERSPECTRAL SENSOR ON THE REMOTE DETECTION OF CORAL REEF HEALTH REGIMES (Abstract ID: 28080)

Conventional in situ monitoring of coral reef health by underwater surveys are spatiotemporally limited and cannot be relied upon to provide regular synoptic coverage of coral reef health. The Hyperspectral Infrared Imager (HyspIRI), with high spatial (60 m) and spectral (10 nm) resolutions in the 380-2500 nm spectral region, provides a promising option for remotely monitoring coral reef health. However, remotely sensed data are inevitably affected by sensor noise. We have quantitatively assessed the impact of sensor noise on remotely detecting coral health status. Coral reefs can be classified based on their health status as follows: (i) healthy calcifying corals, (ii) turf and coral rubble, and (iii) fleshy macroalgae. We used a large dataset of reflectances collected in the Bahamas from all three reef regimes to create representative reflectances for each regime. A robust radiative transfer model was used to propagate the reef reflectance up through the water column and the atmosphere to the sensor platform. We used published values of the expected Signal-to-Noise Ratio (SNR) of HyspIRI to model sensor noise and its effect on the received signal. We considered various ratios of mixed reef regimes for a range of water quality and atmospheric conditions typically expected in coastal waters with coral reef bottoms and quantitatively assessed how the sensor noise affects the ability to spectrally distinguish reef health regime and, given a particular set of water quality, atmospheric, and reef regime mix conditions, what level of SNR is required to detect coral reef health.

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THRESHOLDS IN THE BENEFITS OF BIODIVERSITY FOR MAINTAINING FISH BIOMASS ON CORAL REEFS (Abstract ID: 28774 | Poster ID: 473)

In studies of biodiversity and ecosystem function relationships there has been a disconnect between the results from experimental low-diversity systems and those from high-diversity natural ecosystems. This discord is exacerbated by discussion over the most useful metrics of biodiverseity, while empirical studies have been challenged by the overarching effect of humans on biodiversity loss. Using Pacific-wide surveys of reefs fishes we show that the apparent disconnect between studies of low and high diversity systems may arise as a result of a distinct threshold in biodiversity-ecosystem function relationships. At low diversities biomass increases rapidly, above a low threshold level subsequent increases in biodiversity have moderate benefits. This threshold is seen in all richness metrics while the evenness of phylogenetic diversity provides the best overall predictor of biomass. Our results provide a empirical explanation for the apparent paradox of contrasting BEF relationships in low vs. high diversity systems. Furthermore the findings emphasise the importance of phylogenetic information and the utility of traditional taxonomic groups in identifying practical measures to manage complementarity and maximise potentially harvestable biomass on coral reefs.

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RECOVERY PLAN FOR ACROPORA PALMATA AND ACROPORA CERVICORNIS (Abstract ID: 28161)

In 2006, elkhorn coral Acropora palmata and staghorn coral A. cervicornis were listed as threatened species under the U.S. Endangered Species Act (ESA), and in March 2015, NOAA Fisheries adopted a recovery plan for the two species. The recovery plan identifies a strategy for rebuilding and assuring the long-term viability of elkhorn and staghorn corals in the wild, allowing ultimately for the species' removal from the list of threatened and endangered species. The plan contains ten criteria which are targets by which to gauge species' recovery and identify when they no longer require the protection of the ESA. Twenty-four actions provide direction for achieving the recovery criteria and include research and monitoring, reduction or elimination of threats, and enhancement of the population by growing and actively putting corals back on the reef. Federal resources to implement recovery plans are often very limited. Therefore, communication, coordination, and collaboration with a wide variety of stakeholders are needed to effectively implement recovery actions. Although recovery plans are developed under U.S. law, the recovery plan for elkhorn and staghorn corals can be used as a guide for conservation of

the species in other countries. Because threats to elkhorn and staghorn corals are both local and global in nature, recovery will require concerted effort on the part of domestic and international communities.

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RAPID ACCLIMATION OF JUVENILE CORALS TO CO2-MEDIATED ACIDIFICATION BY UP-REGULATION OF HEAT SHOCK PROTEIN AND ANTI-APOPTOTIC BCL-2 GENES (Abstract ID: 28197)

Corals play a key role in ocean ecosystems and carbonate balance, but their molecular response to ocean acidification remains unclear. In this study, whole-transcriptome analysis was used to compare the effects of acute (3-d) vs prolonged (9-d) exposure to elevated pCO2, in juveniles of Acropora millepora. Acute exposure shows extensive disruption of gene expression, particularly of genes involved in calcification and metabolism. In contrast, the expression of most genes was at control levels after the 9-d treatment, indicative of a rapid molecular acclimation to the altered environment. Heat shock proteins and heat shock factors were over-represented amongst the genes responding to both treatments. The most obvious feature of the molecular response in the 9-d treatment was the up-regulation of five distinct Bcl-2 family members. Our efforts to understand the functional significance of this response led to the characterization of the Bcl-2 and caspase gene repertoires of A. millepora, discussing these in an evolutionary context. The pro- or anti-apoptotic activities of coral Bcl-2 proteins were investigated by expression in mammalian cells. Our results showed that most of the differentially expressed Bcl-2 genes were anti-apoptotic. This suggests that an important component of the corals' longer term response to elevated CO2 is the suppression of apoptosis. Therefore, it appears that juvenile A. millepora have the capacity to rapidly acclimate to elevated CO2, a process mediated by up-regulation of specific HSPs and anti-apoptotic Bcl-2 family members.

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MANGROVE-CORAL HABITATS AS A NOVEL REFUGE FROM CLIMATE CHANGE (Abstract ID: 29603)

More than 90% of the world's coral reefs will be threatened by climate-associate stressors and local anthropogenic impacts by 2030 under "business as usual" emissions scenarios. Increasing temperatures and solar radiation cause coral bleaching that has resulted in extensive coral mortality. Increasing carbon dioxide reduces seawater pH, slows coral growth, and may cause loss of reef structure. Management strategies include establishing marine protected areas where environmental conditions promote reef resiliency. However, few resilient reefs have been identified, and resiliency criteria are poorly defined. We characterized mangrove communities that serve as a novel coral refuge from thermal stress and ocean acidification for more than 30 species of scleractinians growing directly on and under mangrove prop roots in Hurricane Hole, St. John, US Virgin Islands. We identified resiliency factors for these mangrove-coral habitats and show that a combination of substrate and habitat heterogeneity, proximity of different habitat types, hydrographic conditions, and biological influences generate biogeochemical conditions that buffer against ocean acidification. Furthermore, these corals are thriving in low-light conditions from mangrove shading and at higher temperatures than nearby reef corals. In the Florida Keys, red mangroves line 29,000 km of shoreline, thus representing a major potential area of refuge for reef corals. The potential and evidence for mangrove-associate coral refugia in other locations within Atlantic, Caribbean, and Pacific regions will also be discussed.

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THE EFFECTIVENESS OF LOCALLY MANAGED MARINE PROTECTED AREAS FOR CONSERVATION OF COMMERCIALLY IMPORTANT CORAL REEF FISHES IN THE PHILIPPINES (Abstract ID: 28540 | Poster ID: 634)

The Philippines has more than 1,600 locally managed marine protected areas (MPAs), the most in the world. However, most of these MPAs are very small (i.e. average of 0.15 km2) and threats from overfishing are high. In this study, we assessed the effectiveness of 54 locally managed MPAs in the Philippines for conservation of commercially important coral reef fishes. We used the fish biomass level at the nationally managed, large (332 km2), remote (no human settlement), old (established in 1988) and well enforced (i.e. protected for >20 years) Tubbataha Reefs National Marine Park (TRNMP) as a proxy for "unfished" ecosystems (Bo). We also considered fish biomass levels between 25-50% of Bo as biomass "within" the maximum sustainable yield for multi-species coral reef fisheries (BMMSY). Results showed that fish biomass levels in 7%, 25% and 68% of the surveyed MPAs were "above BMMSY", "within BMMSY" and "below BMMSY", respectively. All of the reefs outside MPAs were either "within BMMSY" (16%) or "below BMMSY" (84%). We also observed signs of "fishing down the food webs", wherein the proportion of high trophic fishes decreased with the increasing levels of exploitation rate. Overall, the current locally managed MPAs in the Philippines are not effective enough for coral reef fish conservation but, nonetheless, better than no MPAs at all. Tradeoffs between fishing and conservation, particularly in setting fisheries management targets that would take into consideration both the social and ecological sustainability of coral reef fisheries will be discussed.

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ANTI-PATHOGENIC ACTIVITY OF CORAL BACTERIA AGAINST WHITE PLAQUE DISEASE OF CORAL FAVIA SP. FROM TENGAH ISLAND KARIMUNJAWA INDONESIA (Abstract ID: 29447)

Coral disease is main factor of degrading coral reefs, such as White Plaque (WP) disease that cause loss of epidermal tissue of coral. The purposes of this research were to identify the bacteria associated with White Plaque Disease of coral Favia sp. and to investigate coral bacteria that have antipatogenic potency against White Plaque Disease of Coral Favia sp. Sampling was carried out by purposive method in Tengah Island, Karimunjawa on March 2015. Streak method was used to isolate and purify coral bacteria, while overlay and agar diffusion method were used to test antibacterial activity. Identification of selected bacteria were conducted by biochemical and molecular methods. Polyphasic identification of bacteria associated with diseased coral White Plague of Favia sp. showed that TFWP1, TFWP2, TFWP3 and TFWP4 were closely related to Bacillus antracis, Virgibacillus olivae, Virgibacillus salarius and Bacillus mojavensis, respectively. While antipatogen activity bacterial isolates, NM1.3, NM1.8 and NM2.3 were closely related to Pseudoalteromonas flavipulchra, Pseudoalteromonas piscicida, Vibrio azureus, respectively. Phylogenetic data on microbial community composition in coral will help in the knowledge on the biological control of coral diseases.
http://www.fpik.undip.ac.id

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MOLECULAR DIVERSITY AND HOST SPECIFICITY OF CRUSTACEAN COPEPODS LIVING IN SYMBIOSIS WITH TWO CO-OCCURRING SPECIES OF GALAXEA (SCLERACTINIA) FROM AUSTRALIA (Abstract ID: 28848)

Copepods may be found living in symbiosis with invertebrates of many different taxa, including scleractinian corals. 18 species from 9 genera of copepods representing three orders (Siphonostomatoida, Poecilostomatoida and Cyclopoida) have previously been recorded as symbionts of three species of Galaxea corals (G. astreata, G. clavus and G. fascicularis) from New Caledonia, Indonesia and Madagascar. We studied Galaxea copepod symbionts from three widely separated sites in Australia: Heron Island and Lizard Island (Great Barrier Reef) as well as Ningaloo Reef (Western Australia). Although abundant, many of these symbiotic copepods were previously unknown for Australia. Corals were collected with their symbiont communities using SCUBA at depths from 5 to 21 m. Copepod DNA was extracted using a new method that preserved copepod exoskeletons (body length typically 1-2 mm), enabling morphological study. We analyzed nuclear (ITS2, 18S) and mitochondrial (COI) markers of 337 specimens of all morphotypes

of copepods from 8 colonies of two co-occurring species of Galaxea (G. fascicularis and G. astreata) using specifically-designed primers, revealing a highly diverse fauna of symbiotic copepods. Molecular diversity of these symbiotic copepods, patterns of their distribution and levels of host specificity will be discussed.

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DYNAMICS OF CARBONATE CHEMISTRY, PRODUCTION AND CALCIFICATION OF THE FLORIDA REEF TRACT (2009-2010): EVIDENCE THAT HETEROTROPHY IS DRIVING SEASONAL DISSOLUTION (Abstract ID: 27865)

Are the reefs of the Florida Reef Tract currently in a state of positive carbonate balance? The seasonal variability in the carbonate chemistry of the waters the FRT was followed over a two-year period. Seven surveys were performed at approximately quarterly intervals in 2009-10 across seven onshore-offshore transects comprised of 3-5 stations spanning the upper (UK), middle (MK) and lower Keys (LK). Rates of NCP and NCC were positive during the spring/summer, 50-72 mmol C $m^{-2}$ $d^{-1}$ and 13-20 mmol $CaCO_3$ $m^{-2}d^{-1}$, respectively. During the fall/winter NCP became negative and exhibited a strong north-south gradient (UK -58.3, MK -27.3 and LK -12.4 mmol C $m^{-2}$ $d^{-1}$). This trend was mirrored in the rates of NCC (UK -20.0, MK -6.1 and LK 5.4 mmol $CaCO_3$ $m^{-2}$ $d^{-1}$). A significant correlation was observed between NCC and NCP suggesting that heterotrophy could be a driving factor accounting for the patterns in NCC (NCC=0.0002+0.29*NCP, $r^2$=0.53, P<0.0001). There was also evidence that NCP could be driving some of the temporal and spatial variability in NCC indirectly as &Omega$_{ar}$ was significantly correlated with NCP (&Omega$_{ar}$ =3.65+0.0052*NCP, $r^2$=0.46, P<0.0001). We conclude that the upper Keys are experiencing net dissolution on an annual basis (-0.24±0.2), the middle Keys are in an intermediate state (0.49±0.1) and the lower Keys are in the best condition (0.80±0.2 kg $CaCO_3$ $m^{-2}$ $y^{-1}$).
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EFFECTS OF LIGHT, NUTRIENTS AND THE CIRCADIAN CYCLE ON QUANTITY AND QUALITY OF DISSOLVED ORGANIC MATTER RELEASED BY CARIBBEAN BENTHIC PRIMARY PRODUCERS (Abstract ID: 28743)

Benthic primary producers (BPPs) release a substantial part of their fixed carbon as dissolved organic matter (DOM). This DOM plays a crucial role in the element cycling on reefs, and particularly algal-derived DOM stimulates the growth of opportunistic microbes. While several studies focus on the fate and consumption of DOM, the effects of environmental factors on the DOM release by BPPs are less understood. We thus investigated the effect of light intensity, inorganic nutrient availability, and the circadian cycle (day vs night) on the DOM release of selected BPPs from Curaçao, Southern Caribbean. All macroalgae (*Cladophora* sp., *Dictyota menstrualis, Lobophora variegata*) and turf algae tested at ambient nutrient conditions released DOM, and this release increased with increasing light intensity. When inorganic nutrients (N and P) were added, DOM release by turf algae at low and high light intensities was comparable to those at high light without nutrient addition. Both light and nutrient availability affected DOM release of turf algae, and nutrient availability determined whether light had a positive effect on this release. Benthic cyanobacterial mats (BCMs) and turf algae released large amounts of DOM during the day, but even twice that much at night. Yet, turf algal DOM released during the day stimulated the growth of planktonic microbial communities more than that released at night, suggesting a different quality of the released DOM. Here presented results can help us to better understand DOM dynamics on reefs and to improve carbon flux estimations over diurnal cycles.

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CORAL REEF CONSERVATION AND MANAGEMENT CHALLENGES IN SOUTH ASIA (Abstract ID: 28521)

South Asia is home to over 250 species of coral reef, over 1200 reef associated fish species, around 10 % of the world mangroves and over 100 globally threatened species are recorded from coastal and marine habitats and is hosting the Maldives-Chagos-Lakshadweep Atolls which is the largest atoll system in the world. South Asia has 19,210 km² of coral reef which is about 6% of the world's coral reefs. Coastal and marine ecosystems support very rich species diversity in South Asia. South Asian region having extensive river deltas and diverse marine and coastal habitats supporting marine biodiversity, however coral reefs are facing numerous threats due to natural and anthropogenic factors. Nearly one third to half of coral reef resources of South Asia are now effectively dead and further 30 percent are threatened. Consequently, livelihoods of many reef dependent communities are at risk. The management and conservation of coral reefs is one of the most challenging tasks for conservationists and marine bio-resource managers in South Asia. The South Asia Coral Reef Taskforce (SACRTF) was established in five South Asian countries sharing the Indian Ocean to facilitate and coordinate in the management of coral reefs and associated ecosystems at national level and to promote collaborative action at the regional level aiming at encouraging trans-boundary responses to shared environmental challenges and raising South Asia Cooperative Environment Programme (SACEP) is the regional coordinating agency of SACRTF.
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MESOPHOTIC CORALS OF NORTHEAST AUSTRALIA: INITIAL ESTIMATES OF THE POTENTIAL FOR DEEP-REFUGE (Abstract ID: 28484)

Northeast Australia has a rich diversity of coral reef systems that includes the Great Barrier Reef and atolls of the western Coral Sea. While the shallow reefs are relatively well studied in the region, mesophotic coral communities (>30-40 m depth) are not well documented. Here we present results obtained from the study of a large coral collection compiled over eight expeditions from 2007 to 2014 that used deep diving, remotely operated vehicles and dredge sampling to investigate the mesophotic zone. The collection, housed at the Queensland Museum Townsville, includes at least 59 genera and 165 species (including five potential new species), with 93% of species depth generalists (occurring in both shallow and mesophotic zones) and 7% restricted to the mesophotic zone. Approximately 28% of the depth generalist species were only rarely observed in the mesophotic zone and the possible origins and significance of these records are discussed. Recent studies suggest a relatively large area of mesophotic coral habitats in the GBR region, and while our sampling effort was relatively small, these initial results suggest that the mesophotic zone has potential for providing deep-refuge for up to 37% of shallow-reef coral species in the region. Further work on the ecology, reproduction, physiology and phylogenetics of these species are urgently required to assess the potential for deep-refuge as the shallow reefs of the region are widely predicted to be subjected to increased coral bleaching and damage from tropical storms in coming decades.

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MICROBIAL COMMUNITIES ASSOCIATED WITH SPONGE ORANGE BAND DISEASE IN THE GIANT BARREL SPONGE, *XESTOSPONGIA MUTA*(Abstract ID: 27928 | Poster ID: 151)

The giant barrel sponge, *Xestospongia muta*, represents an ecologically important species of Caribbean coral reefs. In April 2012 Sponge Orange Band (SOB) Disease spiked highly in Southeast Florida. The disease began with typical mesoyl bleaching, necrosis and often total sponge disintegration. Near the outbreak peak, 20 *X. muta* individuals were collected from two diseased populations to examine the etiology of the disease microbiomes of diseased and healthy sponges. From each diseased individual, three different morphological stages of SOB disease were collected and compared: visually healthy mesohyl from diseased sponges (HoD); the boundary layer (BL) of healthy and diseased mesohyl; and diseased mesohyl from diseased sponges (D) (N=14). Additional healthy controls (HC) mesohyl from adjacent non-diseased sponges (N=6), ambient seawater and sediment were also collected and compared. A total of 51 distinct 16S rRNA amplicon libraries were constructed with V4 primers, yielding a total of 228,315 pyrosequence reads. Beta-diversity analyses showed that healthy mesohyl had less microbiome variability than BL and diseased *X. muta* mesohyl. Although specific SOB pathogens were not confirmed, we found 22 OTUs clearly associated with SOB disease. These taxa included significant increases in *Flavobacteria, Verrucomicrobia, Plantomycetes, WPS-2* and *ZB3*. Two OTUs were always detected in the BL, while *Poribacteria* disappeared in D and BL. This study provides an extensive profile of microbial communities within X. muta with implications of a possible polymicrobial origin for SOB.

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THERMAL STRESS CAUSES A SIX-FOLD INCREASE IN THE RISK OF DISEASE INFECTION IN ACROPORA CERVICORNIS (Abstract ID: 27830)

Over the last several decades diseases have caused significant declines in coral populations throughout the Caribbean. Yet we know little about the proportion of populations that are resistant to disease, and even less about the influence of the environment on disease virulence and host vulnerability. The objectives of the present study were to: i) determine whether different genotypes of Acropora cervicornis from the Florida Keys were resistant to disease, and ii) quantify the change in disease risk when corals were bleached. Five replicates of 15 genotypes were exposed to tissue slurries created from corals showing signs of disease in August 2015, before thermal stress and bleaching. The same 15 genotypes were again exposed to disease tissue slurries in late September 2015, during peak bleaching. A set of controls, which used tissue slurries created from apparently healthy corals, were paired with each experimental treatment. The relative risk of tissue loss, using a Bayesian framework, determined the risk of disease after exposure to the disease slurry, and quantified whether bleaching significantly increased disease risk. Disease exposure prior to bleaching doubled the risk of disease for twelve genotypes, whereas after bleaching the median risk increased six-fold. When bleached, eighty percent of the genotypes had a significant increase in risk of disease. Interestingly, two genotypes remained disease resistant even after bleaching. These results signify the critical role that both genetics and the environment play in coral-disease dynamics.

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TESTING MITIGATION TECHNIQUES TO STOP THE PROGRESSION OF CARIBBEAN YELLOW-BAND DISEASE ON ORBICELLA FAVEOLATA (Abstract ID: 29017 | Poster ID: 474)

Caribbean yellow-band disease has caused extensive mortality of Orbicella faveolata, often affecting colonies that were hundreds of years old. The slow progression of yellow-band disease, however, provides an opportunity to test methods to mitigate disease progression. We tested three different mitigation techniques to determine whether the progression of the yellow band could be slowed or stopped using applied approaches, including: 1) the application of a shade cloth, 2) the aspiration of diseased tissue, and 3) the creation of a physical trench, or firebreak, between the diseased and healthy tissue using a hammer and chisel. Each technique was tested on three replicate colonies, and another three colonies with yellow bands were monitored as controls. The colonies were revisited after four and seven months to determine rates of success. Disease progression under the shade cloth was similar to the controls, and all aspirated corals regrew the diseased tissue, indicating that these two mitigation methods were ineffective. However, two of the three chiseled colonies showed no apparent signs of disease within the isolated healthy tissue after seven months. One colony showed small patches of discolored tissue, where the trench was likely created too close to the yellow band, suggesting that the barrier may need to be widened, removing both diseased and some healthy tissue to increase effectiveness. These results indicate that creating a firebreak between diseased and healthy tissue, which takes minimal effort and resources, may prolong the life of long-lived coral colonies.

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HIGH-RESOLUTION BATHYMETRY IN SELECT PHILIPPINE REEFS AND THEIR IMPLICATIONS ON THE LATE PLEISTOCENE-HOLOCENE SEA-LEVEL CHANGES AND REEF DEVELOPMENT (Abstract ID: 29201 | Poster ID: 400)

Coral reefs provide an effective archive to past sea levels because reef-forming corals grow at a limited depth range and have a good geologic preservation. High-resolution multibeam bathymetry to a depth of 70m show a series of terraces and steep scarps in Apo Reef, Occidental Mindoro; Masinloc, Zambales; and Patnanungan, Quezon in the Philippines. Diver and drop-camera observations indicate the proliferation mesophotic corals especially along the edges of terraces. The terraces are interpreted to represent reef flat to reef crest environments and scarps as reef fronts. These are possibly the back-stepping reefs that were drowned during the overall rise of sea level. Mounds with reliefs of 2-10 m along the edges of terraces in Apo Reef and Patnanungan may represent catch-up growth. This may have been made possible by a deeper photic limit, greater depth range of coral assemblage and relative protection from wave action in the sites. Comparison of the distribution of the depths of the terraces across reefs shows clustering in three depth ranges which may correspond to three sea-level stillstands in the past 12-14 ky in the South East Asia. Variations in depth and number of terraces may indicate local tectonic influence. This provides an opportunity to extend the sea level record in the Philippines towards the Late Pleistocene.

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ADAPTING BIOPHYSICAL PRINCIPLES FOR MARINE RESERVE DESIGN FROM CORAL REEF ECOSYSTEMS TO ROCKY REEFS IN A TEMPERATE SYSTEM IN THE GULF OF CALIFORNIA (Abstract ID: 29824)

The Gulf of California is a biodiversity hotspot and supplies more than half of Mexico's fisheries. We adapted biophysical marine reserve design principles originally developed for coral reefs to the unique evolutionary, oceanographic and ecological characteristics of the Gulf of California. While the amount of habitat representation and replication within reserves could be similar to that recommended elsewhere, this approach would need to be replicated within three well-defined biogeographic sub-regions. Unique sites for protection include hydrothermal vents, the northern most coral reef in the eastern tropical pacific, places showing exceptional richness of endemics and overall species diversity and sites with high productivity year-round. Given that strong, unidirectional oceanographic currents reversing direction twice a year characterizes the area and larval dispersal is ~100 km, reserves should be spaced 50-100 km apart and the location of reserves should consider the reproductive timing of the focal species (e.g. locate reserves upstream of fishing sites in relation to the direction of the predominant flow). Recovery times should be similar to other places (20-40 years), but consider local baselines. In terms of climate change, habitats and species more likely to be resistant should be prioritized. Climate change might affect larval dispersal, species' distribution, growth, reproduction, and ecosystem function and dynamics, which may require modifying recommendations about habitat representation and replication, size, spacing duration and location in future.

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INFLUENCE OF PHYSICAL AND STRUCTURAL HABITAT VARIABLES IN ECOLOGICAL COMMUNITY INDICATORS AND BLEACHING OF CORALS IN A PROTECTED AREA OF THE GULF OF MEXICO (Abstract ID: 29350 | Poster ID: 350)

Coral reefs offer many ecological services; yet, these are affected by various stressors causing impacts that decrease the resilience of these ecosystems. The main objective of this study is to relate the influence of physical and structural factors of the habitat, in the composition, structure and the condition of bleaching of hermatypic corals (Anthozoa:Scleractinia and Hydrozoa:Milleporina), in order to develop an ecological resilience index. The research was conducted in the National Park Arrecife Alacranes (NPAA), a natural protected area considered one of the largest reefs in the Gulf of Mexico. Due to its geographical location, it has a relatively low human impact, so it is of great importance for the study of the potential impact of natural stressors. The methodology implemented was the BLAGRRA optional belt transect (slightly modified), remote sensing data (SST by the AVHRR sensor and diffuse attenuation coefficient K490 AQUA-MODIS sensor) and spatial information obtained by previous works in the NPAA. The results suggest that species *Siderastrea siderea, Porites astreoides, Millepora complanata* and the *Orbicella* and *Undaria* genus are the most affected in the study area. In general, it is not considered that there is an event of mass bleaching in the NPAA, however, the variability in the SST and the K490 can be of great relevance in coral bleaching at the local level.

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EXPLORING THE FUNCTIONAL ROLE OF A COMMON HERBIVORE IN MOOREA, FRENCH POLYNESIA (Abstract ID: 30108 | Poster ID: 248)

Understanding mechanisms that contribute to coral persistence is recognized as a high priority research topic. Herbivory is an important mechanism that prevents macroalgae from dominating disturbed coral reefs. In this study, we focused on the feeding ecology of herbivorous fish species in Moorea, French Polynesia. Using video recording and field assays, we analyzed the foraging behavior of common herbivores in the lagoon

reef habitat. Our results show that 7 of 8 herbivorous fish species fit conventional Indo-Pacific functional group classifications, with the exception of the bullethead parrotfish, *Chlorurus sordidus*. Previous research has classified the bullethead as an excavator of epilithic turf algae, however our results show this species takes 40% of bites on macroalgae. Additional foraging observations of 138 individual bulleteads of various sizes suggest this species may be more of a generalist herbivore, consuming multiple species of macroalgae in addition to turf. Creating a selectivity index based on food availability and mass specific bite rates will confirm if the role of the bullethead can be context dependent on fish size, reef habitat, and benthic cover. As one of the most abundant herbivores in Moorea, the bullethead likely plays a major role in coral reef communities. The results of this study contribute to the understanding of how different functional groups drive community composition and function.

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A GEOSPATIAL ASSESSMENT OF COMMUNITY CARBONATE PRODUCTION AND BIOEROSION ON THE SOUTHERN AND WESTERN COASTS OF GRAND CAYMAN (Abstract ID: 28367)

Calcium carbonate production and bioerosion are key factors controlling coral reef growth and the maintenance of reef structural complexity. Thus, ecosystem services dependent on physical reef structure are influenced by changes to the balance between these controlling factors; a carbonate budget is used to determine this balance. Recent research has identified a dramatic decrease in carbonate production on Caribbean coral reefs in response to declining coral cover and reef carbonate budgets may not be sufficiently net positive to continue providing these essential ecosystem services. Here we present a geospatial assessment of carbonate production and bioerosion by biological communities along 26 km of coastline on Grand Cayman. Census surveys allowed the calculation of carbonate budgets at 23 sites within the major habitat types found on Grand Cayman – hardgrounds, relict Acropora palmata reef and Orbicella reef. Habitats were mapped using ground-truthed aerial images and net carbonate production characterised within the investigated area, from the reef crest to a depth of 15 m. Mean net carbonate production was positive on Orbicella reefs, but only marginally so on relict A. palmata reefs (1.26 and 0.34 kg CaCO3/m2/yr respectively). Hardgrounds were net erosional (mean = -1.05 kg CaCO3/m2/yr). The results highlight reef sites which have become net erosional and can no longer maintain their structural complexity, while also identifying coastal locations that may be at risk from flooding as sea level rises and reef habitats produce less calcium carbonate.

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ANALYSIS OF ANTIOXIDANT ENZYME EXPRESSION OVER REPRODUCTIVE TIME POINTS IN POCILLOPORA DAMICORNIS (Abstract ID: 28478)

Continued degradation of coral reefs around the world, particularly within NOAA's Hawaii National Marine Sanctuary, is an alarming call for action towards the identification of stressors and subsequent rehabilitation of these national resources. Aligned with the goals of NOAA's National Marine Sanctuary to protect areas of the marine environment that are of special national significance to cultural, scientific, educational, and ecological values, this research targets addressing and standardizing antioxidant enzyme stress levels in Hawaiian coral over reproductive cycles in order to increase management aptitude and efficiency. By developing a greater understanding for biochemical biomarkers of stress in corals, specifically through the study of superoxide dismutase, catalase, glutathione peroxidase, and glutathione reductase activity and expression, this research will aid in the adaptation and further development of biochemical tests to understand baseline thresholds of stress on coral reefs within Sanctuary waters. Although findings suggest that reproductive cycling may not be a significant factor affecting the activity and expression of this suite of enzymes, these baseline findings will be further applied to diagnostic tests describing the effect of different physical environmental factors and chemical pollutants on coral health. Through this application we look to improve our ability to identify ecological issues and expand the knowledge of local communities and NOAA, so that steps can be taken to mitigate human Sanctuary impacts.

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SUPPORTING COASTAL COMMUNITIES TO ACHIEVE A SUSTAINABLE AQUARIUM TRADE (Abstract ID: 29739 | Poster ID: 602)

Harvesting fish and invertebrates from coral reefs to supply the global aquarium trade is driven by the aquarists' desire to showcase the most diverse and rare ornamental reef species in their home aquaria. As a luxury hobby the industry is highly controversial. It has contributed to species over-exploitation (e.g. clown fish following "Finding Nemo") and has been identified as a causal factor in habitat loss and degradation through the use of damaging and illegal fishing practices. However, many advocates of the industry believe that if well-managed, it could provide economic stability in low-income coastal communities whilst incentivising the maintenance of a healthy marine ecosystem. Research conducted in the Philippines found that aquarium fishers still receive minimal margins for their catch despite the expansion of the global market. They are also driven to fish with increasing distance from their local reefs where reef stocks have already been depleted, raising operational costs and further pressurising the small financial margins within which aquarium communities operate. Few alternatives to wild collection exist and development of aquaculture is limited by the costs associated with rearing tank bred fish compared to one harvested from the wild. Through engagement with local communities of aquarium fishers, an assessment of how "fair" the trade currently is in combination with socio-economic and biodiversity assessments are being trialed to develop a framework to aid local governments in the management of aquarium fisheries to provide a sustainable future.
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CORAL DIVERSITY AND THREATS IN THE INTERTIDAL ZONE OF WATAMU MARINE NATIONAL PARK, KENYA (Abstract ID: 29205 | Poster ID: 627)

Research in tropical marine protected areas tends to focus on relatively deeper coral reefs, neglecting potentially biodiverse habitat such as the rocky intertidal zone. The high diversity and interesting features of Watamu Marine National Park, Kenya, attracts wildlife tourism. These intertidal habitats have been overlooked by research and management of this no-take MPA, with more effort directed towards lagoonal patch reefs. The aims of this study were to assess the population patterns and ecology of a rare coral Anomastraea irregularis, document coral diversity, and assess threats to these species in these habitat in the park. Belt transects were used to assess the number and surface area of colonies of Anomastraea. Percentage composition of substrate type was estimated. Coral condition was noted. Colonies of other coral genera were recorded. Participatory observation was used to assess threats posed by use of these habitats. 156 colonies of Anomastraea were recorded in an area of 1500 m2. The southern part of the park, near a tidal inlet, had the highest number of colonies, the largest colony and the widest size range of colonies. Thirteen other coral genera were recorded. Tourists interacted with the habitat through guided tours by local untrained guides, and involved touching, poking and feeding species such seastars and moray eels. The lack of biological knowledge and awareness of the sensitivity of the habitats poses a risk to the wildlife. There is an urgent need for training of guides, sensitization of tourists, and a management plan for this habitat.
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COMMUNITY FISHERS' FORUM AS A MEANS TO FACILITATE THE UPTAKE OF SCIENCE INTO SMALL-SCALE FISHERIES CO-MANAGEMENT (Abstract ID: 29965)

Co-management is a key approach that is increasingly being used to manage small-scale fisheries (SSF) across the western Indian Ocean (WIO). This is resulting in increased responsibility on fishers who previously were not involved in management, yet there are few examples of learning programs in the WIO that provide scientific information that meets fisher management capacity needs. Uninformed fishers will not be able to play their part in co-management, reducing the benefits of this governance system. We describe here a co-management partnership, the Fishers' Forum, aimed at promoting the use of scientific information in the management and conservation of coral reefs in Kenya. The forum, a partnership between fishers through their Beach Management Units and other associations, the State Department of Fisheries and the Wildlife Conservation Society, has over a 15-year period grown to an annual event of more than 150 actors and practitioners in the coastal SSF sector across the Kenyan coast. We describe the adoption, outcomes and challenges of fisheries management measures discussed at the forum during this period. Learning was achieved through an iterative process that involved scientists presenting findings annually from monitoring and research studies on coral reefs and making management recommendations, and fishers using the platform to discuss the feasibility of management options and implementation of solutions. This resulted in increased fisher community participation and the use of science in the management of SSF. The Fishers' Forum, can serve as a useful model for the WIO where governance of SSF is increasing being restructured towards co-management.

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SKELETAL PROPERTIES AND MECHANICAL STRENGTH OF KENYAN SCLERACTINIAN CORALS UNDER SEDIMENT DISCHARGE (Abstract ID: 29191 | Poster ID: 440)

Coral reefs are maintained by the close balance between constructive and destructive processes. However, disturbances that impair carbonate production or facilitate carbonate destruction can potentially push coral reefs into states of degradation. There is growing concern that rapid changes in global and local environmental factors are increasing the severity of reef damage, particularly in nearshore reefs adjacent to modified catchment areas. Mechanical properties of coral skeletons are important determinants in the survival of corals by limiting colony or branch size, range of hydraulic conditions colonies can withstand, selection of suitable habitat and influencing growth form characteristics. Skeletal properties also play a significant role in the ability of corals to compete for space and light, repair structural damage, and withstand the impacts of hydrodynamic energy and bioeroding organisms as well as the maintenance and structuring of coral assemblages. Predicted increases in SST, atmospheric CO2 and water quality changes will potentially combine to modify coral calcification and coral skeleton properties consequently undermining coral fitness and resilience. Previous studies have shed some light on the consequences of skeleton property modification and morphology. However, few studies have been undertaken to elucidate the influence of sediment concentration on the consequences of coral skeleton modifications. Here we report on the response of coral skeletons (skeleton properties and mechanical strength) to the influence of sediment discharge.
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IMMUNITY TO COMMUNITY: WHAT CAN IMMUNE PATHWAYS TELL US ABOUT DISEASE PATTERNS IN CORALS? (Abstract ID: 28202)

Not all coral species are affected by disease equally. Some species are host to different diseases, but seem to successfully fight them reducing mortality. Other species are disproportionately infected on any given reef and experience high mortality due to disease. We are interested in the role immunity can play in directing these patterns and are evaluating coral immunity using several novel approaches. We exposed 4 species of coral, Orbicella faveolata, Pseudodiploria strigosa, Porites porites and Porites astreoides, to the immune stimulator, LPS and quantified the changes using a combination of full transcriptome sequencing and protein activity assays for gene to protein analysis. We mapped gene expression changes using KEGG pathway tools onto key immune pathways including melanogenesis, complement cascade and Toll-like receptor (TLR). We found many differences among species in the presence of certain pathway components, and in expression with LPS exposure. For example, O. faveolata down-regulated many genes in the melanogenesis cascade and TLR pathway while P. strigosa up-regulated much of these pathways. O. faveolata also had many 'dysfunctional' regulated genes, while both Porites species had far fewer identified genes in these pathways with little to no change in their average expression. We will present our data for these species of coral and assess how these transcriptional and protein responses are related to disease susceptibility in nature.
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ENSURING EFFECTIVE CO-MANAGEMENT OF MARINE PROTECTED AREAS IN THE MESOAMERICAN REEF: STRATEGIES FOR INVESTING IN LOCAL MANAGEMENT (Abstract ID: 29822)

Marine protected areas (MPAs) are a common strategy used worldwide to improve coral reef health. However, MPAs are only successful if they are effectively managed, which requires local capacity and sustainable financing. On the island of Roatan in Honduras, the Sandy Bay West End MPA was declared in 1989, but lack of adequate funding, personnel, and capacity resulted in little-to-no management of the MPA. In order to fill this gap, the Government of Honduras created a co-management scheme that allows local NGOs to manage MPAs in collaboration with the government. The Roatan Marine Park (RMP), a local NGO co-manager, was legally established in 2008 to manage the Sandy Bay West End MPA. The Coral Reef Alliance, an international NGO, has supported RMP since its establishment and has strategically invested in its growth with the long-term goal of creating a self-sufficient and autonomous local management entity. As a result, RMP is now effectively managing the west end of Roatan and is 86% independent. CORAL's strategic support for RMP through sub-grants, capacity building, and strategic planning has progressively helped them to gain financial and management sustainability. The end result that the reefs within the MPA are healthier reef than adjacent areas. Our inclusive, thorough and collaborative process for empowering local co-managers in the Bay Islands, particularly RMP, has successful emergent properties that can be applied to strengthen management of other MPAs within Honduras and beyond.

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SHOALING REDUCES METABOLIC RATE IN A GREGARIOUS CORAL REEF FISH SPECIES (Abstract ID: 28897)

Many coral reef fishes live in cooperative groups due to the benefits that sociabillity can confer, such as reduced energetic requirements to fuel a variety of basic processes. Most studies on this topic have focused on the reduced costs of locomotion in collectively moving fish, in which trailing individuals can take advantage of the vortices produced by leading fish to maintain swimming speed with reduced effort. Theory suggests that individuals in social groups may also be able to reduce their energy spent on vigilance, as fish groups exhibit improved threat detection by having "many eyes" to scan for predators. In addition, individuals accustomed to a social environment may exhibit reduced stress levels when exposed to shoaling conditions. How these effects may influence overall metabolic demand, however, remain poorly understood. In this study, we quantified the impacts of shoaling on the metabolism and body condition of a gregarious coral reef fish species, the shoaling damselfish *Chromis viridis*. Using a novel respirometry method, we found that the presence of shoal-mate cues led to a significant reduction in the standard metabolic rate (SMR) of individuals. Although all fish were fed a body-mass specific feeding regime, fish held in isolation exhibited a significant reduction in body condition following one week in treatment when compared to those held in shoals. As environmental disturbances like tropical cyclones have the potential to induce social isolation, these results could have ecological consequences for gregarious fishes on coral reefs.

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ASSESSMENT OF DATA-POOR CORAL REEF FISH POPULATIONS USING LIFE HISTORY PARAMETERS OBTAINED THROUGH A STEPWISE MONTE CARLO SIMULATION APPROACH (Abstract ID: 29613)

Coastal fisheries in tropical areas usually target dozens, sometimes hundreds, of species and are typically managed with limited resources. Some parsimonious stock assessment approaches rely on easily obtainable length data and are useful in data-limited situations. However, these methods still require information on key life history parameters (growth, natural mortality, and maturity) which is missing for the majority of exploited tropical species. We present a new approach to obtain life history data by using information on maximum length, taxonomic group, and the relationships between key life history parameters to obtain probability distributions of these parameters for unstudied species. We used this approach, combined with length data obtained through commercial and diver surveys, to calculate probability distribution of fishing mortality rates and spawning potential ratios (SPR) for 25 species of Hawaii coral reef fishes. For 17 of those species, we had actual life history parameters obtained from the literature which we used to conduct regular assessments and compare the results from the data-poor approach. We obtained good agreement between the data-poor approach and the results obtained with actual life history parameters: the status of 15 of the 17 previously assessed stocks was correctly classified using this method. Of the 25 species assessed in this study, slightly less than half were classified as having SPR < 30%. The longer-lived species (surgeonfishes and snappers) typically had lower SPR values in contrast to shorter-lived ones (goatfishes and jacks).

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RELATIONSHIP BETWEEN SUBSTRATA DISTRIBUTION AND AMOUNT OF PRIMARY PRODUCTION: ITS SPATIO-TEMPORAL CHANGE (Abstract ID: 30094)

The primary production of each substratum: sediment or benthic communities, on coral reefs have been measured. For example, Nakamura et al. (2016) in this ICRS measured on Sesoko Island reef in Ryukyu Islands. Using these data, this study examines relationship between substratum distribution and primary production on 2 fringing reefs in

Ryukyu Islands: Sesoko reef in Okinawa Island and north eastern reef in Yoron Island. The procedure is as follows: (1) Substrata distribution pattern and its area were obtained by field survey and aerial photo reading. (2) Based on amount of primary production per unit area among each substratum, total amount of primary production was calculated about each reef. In the case of Yoron Island, we obtained aerial photographs of three eras. The oldest era was 1945, the reef flat was covered with rich coral communities. The middle era was 1960s, because of the typhoon disturbance, most reef flat was covered by sand and gravel. The last era was 1977, coral communities recovered from typhoon disturbance. Using these aerial photographs, the change of substratum distribution and the amount of primary production on Yoron Island's reef for the past 70 years was considered. In addition, using similar method, the evaluation about the loss that occurred for reclamation work on coral reef was considered in the case of Ishigaki new airport construction that was planned before.

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POPULATION GENETIC ANALYSIS AT VARIOUS SPATIAL SCALES OF THE BROADCAST-SPAWNING CORAL, *GALAXEA FASCICULARIS*, IN THE NANSEI ISLANDS, JAPAN (Abstract ID: 28277 | Poster ID: 181)

Estimation of species diversity and genetic connectivity is essential for management of coral populations. At various spatial scales, we analyzed sequence types of the mitochondrial DNA (mtDNA) non-coding region and microsatellite multilocus genotypes of the broadcast-spawning coral,*Galaxea fascicularis*, in the Nansei Islands, Japan. Two morphological types are known in *G. fascicularis*, and these are strongly correlated with the length of the mtDNA sequence. Using microsatellites, significant genetic differentiation was detected between mtDNA sequence types. We also found a third genetic cluster, and this unexpected mtDNA type may be a cryptic species of *Galaxea*. Furthermore, significant genetic differentiation within mtDNA types was found among four geographic regions spanning 750 km. Nevertheless, intraspecific genetic diversity and connectivity have been maintained in the Nansei Islands. For fine scale analysis within a site, spatial genetic structure was analyzed based on location of each colony at four sites in the Nansei Islands. Clonal diversity was calculated in both mtDNA types; however, values differ among sites. Using both sexual and asexual reproduction, this species apparently has the potential to recover populations damaged by anthropogenic insults.

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CORAL FARMING AND OUT-PLANTING BY MEANS OF CORAL REEF PRESERVATION AND REHABILITATION IN OKINAWA (Abstract ID: 28545 | Poster ID: 486)

The number of reef-building coral species distributed in Okinawa is approximately 380, which occupies approximately 95% of the total number of species known from the Japanese waters. In 1998, Ministry of the Environment Government of Japan reported that Okinawa possesses a total of 28,235 ha of coral reefs, which occupies approximately 84% of all coral reefs in Japan. According to the Okinawa Prefectural Government's coral reef survey in 2012, average coral cover in Okinawan reefs remained very low. Coral cover was below 10% in a large part (nearly 80%) of Okinawan reefs. Most coral communities have not recovered to the pristine level that was observed in early 1970s. The causes of this degradation in coral communities are thought to be; repeated outbreaks of the Crown-of-Thorns Starfish (Acanthaster planci), mass coral bleaching events, heavy soil runoff and deterioration of water quality. In Okinawa, coral out-planting to rehabilitate coral communities was implemented though these activities were carried out in a small scale. Therefore, Okinawa Prefectural Government launched the Coral Reef Preservation and Rehabilitation Project in 2011. The project comprises research on genetic structure of corals, coral seed production using sexual and asexual reproduction and field tests on large scale coral propagation by out-planting. As of March 2015, 75,000 coral seeds were out-planted in a total of 1.72 ha reef area. Approximately 140,000 more seeds are projected to be planted in a total of 3.3 ha reef area, which could be the world's largest attempt in coral out-planting.

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POPULATION DYNAMICS OF THE CROWN-OF-THORNS STARFISH ALONG THE WEST COAST OF OKINAWA ISLAND VIEWED FROM LONG-TERM REMOVAL DATA (Abstract ID: 28298)

Coral communities along the coast of Onna village, the central west of Okinawa Island, have suffered from predation by chronically high-density populations of the crown-of-thorns starfish, *Acanthaster planci*. To protect corals, Onna Village Fisheries Cooperative began eradication programs in 1989. The cooperative has been recording size-frequency of removed starfish individuals in five different areas along the coast since 2003. Using these data, we previously revealed that successive recruitment could be one of the driving factors maintaining *A. planci* population at high density. Here, we re-examine the removal data of Nakamura et al. (2014) in addition with data of year 2013–2015 in order to establish a prediction model of *A. planci*population along the coast. Fluctuations in population size for each of the five areas shows different patterns over the years. Assuming that a majority of juvenile individuals stays during their growth in the same area along the coast, the number of juveniles which survived removal due to their small size could appear in the following year. In fact, the number of individuals < 15 cm in Year(t) (generally younger than two years-old; Okaji et al., unpubl. data) well reflects the total number of removed individuals born in Year(t–2). These findings could allow us to predict the number of individuals and to make appropriate budget projections for an eradication program of *A. planci*in the future.

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MEASUREMENT OF CARBON PRODUCTION BY PHOTOSYNTHESIS AND CALCIFICATION OF SHALLOW LAGOON IN SESOKO (Abstract ID: 28611)

The lagoons in Okinawa also, were affected by a large-scale coral bleaching in 1998. Some of the lagoons have been recovering until now. However, there are any lagoons that have not recovered yet. Sesoko beach lagoon locating at north part of Sesoko Island in Okinawa, Japan is known to be one of the not recovered lagoon. Carbon production of calcification and photosynthesis can be an indicator of a state of the coral reefs to observe the recovery processes quantitatively from the bleaching event. It is important to estimate the production at each different benthic community to integrate as a whole lagoon metabolism since reef community has extremely heterogeneous structures. In this study, photosynthesis and calcification rates at each different substrate in Sesoko beach lagoon were measured for a year to see the recovery state of this lagoon. Clear acrylic domes with sampling bottle were deployed on three different bottom types in a mort of Sesoko beach every month for about a year from 2014. Dissolved oxygen, pH, salinity and total alkalinity of the collected seawater were measured. Calcification and photosynthetic rates per unit area were calculated in each dome from the change in total alkalinity and total inorganic carbon. A decrease trend was seen at community production rate obtained through one year, suggesting the possible decline of reef community. As the rock and gravel substrates showed higher reduction rate of carbon production than coral substrate, indicating that this lagoon was irreversibly deteriorate as a whole reef system after bleaching event in 1998.

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REEF-SCALE MODEL SYSTEM FOR EVALUATING AND PREDICTING CORAL RESPONSES TO OCEAN ACIDIFICATION AND SEA-LEVEL RISE (Abstract ID: 29282)

For evaluating and predicting coral responses to future environmental changes in the reef scale, the coral polyp model developed by Nakamura et al. (2013), which can well reconstruct the coral responses to ocean acidification, flow conditions and others, was incorporated into a reef-scale model based on a 3D hydrodynamic model (ROMS) following the Carbonate System Dynamics (CSD) model (Watanabe et al. 2013). The developed modeling system was applied to the Shiraho fringing reef, Ishigaki Island, Japan, and it was confirmed that the model system well reconstructed the spatiotemporal variations of the reef environmental parameters. A scenario analysis under several $pCO_2$ and sea-level conditions, following IPCC scenarios, was conducted by using the modeling system. The simulation results indicated that the coral calcification rate will decrease with increasing $pCO_2$. On the other hand, when the sea-level will increase, the calcification rate especially in the inner reef area will increase because both the mass exchange between the corals and their ambient seawater and that between inside and outside of the reef will be enhanced under higher flow conditions. When both $pCO_2$ increase and sea-level rise will concurrently occur, basically calcification rate will decrease due to ocean acidification effect, but only under the best case scenario (RCP2.6), calcifica-

tion rate in some inner reef areas will increase because positive effect by sea-level rise prevails against negative effect by ocean acidification.
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CHALLENGES FOR CONSERVING PALAU'S CORAL COMMUNITIES BY P-CORIE (Abstract ID: 28123)

A joint research project called P-CoRIE (Palau Coral Reef Island Ecosystem) has started in April 2014 under the umbrella of JST/JICA SATREPS scheme. During the project, permanent quadrats were established and monitored at 14 sites pallalel to the temperature monitoring around Palau since 2014. The preliminary results from first two years showed that inner reef sites were predominated by massive Porites spp. while the outer or near-outer reef sites were mainly consisted by tabular or branching Acroporid corals. The average coral cover at the sites varied between <5% to >85% with most of the sites kept >70% coral cover. However, with site-by-site uniqueness, the coverage changed drastically in several sites within a few years period. In addition to the aspects of natural science field, we'll further discuss how we can utilize these results in terms of integration with social aspects of reef conservation.

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THE IMPACT EXTENT OF REGIONAL ENVIRONMENTAL FACTORS IN THE RECOVERY PROCESS OF THE CORAL COMMUNITY IN TERRAINS ESTABLISHED VIA DIFFERENT GEOLOGICAL HISTORIES. (Abstract ID: 29135 | Poster ID: 414)

Okinawan coral communities (CCs) suffered catastrophic impacts in the large-scale bleaching event of 1998 and subsequent repeated bleaching events. The recovery processes of CCs varies by location. In more detailed observations, the degree of recovery of the microtopography of coral reefs within the same location is different. This difference is due to the interactions among the following elements; physiochemical environment, relationships with other organisms, and the ecology of coral itself. In many cases researchers have monitored the recovery process of some elements of CCs, but whole ecosystems have not evaluated. To undertake a comprehensive evaluation of ecological areas by performing a correlation calculation between elements, it is necessary to select the elements with the strongest impact. However, coral reefs have different development histories in each region, and for each microtopography, and current CCs reflects these histories as a succession. In succession of CCs, the degree of impact of each environmental factor is different. In our project, we evaluated the interaction of physical and chemical environmental factors and coral-associated bacteria, and attempted to evaluate the degree of influence of the environment on the coral and CC by analyses of coral-associated bacteria. First of all, we evaluated the impacts of environmental factors in the succession of CCs in different terrain environment. Physical factors were suggested to have the greatest effect on the determination of the recovery of community structure.

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ELUCIDATING FOOD SOURCES FOR LARVAL STAGE OF CROWN-OF-THORNS STARFISH BY STABLE ISOTOPE ANALYSIS (Abstract ID: 29120)

It has been a center of interest for decades to understand the mechanism by which the crown-of-thorns starfish (COTs), *Acanthaster planci*, explosively increases their population in natural environments. One of the major hypotheses is that the increase in phytoplankton abundance induced by eutrophication of coastal waters contributes for their higher larval survival rate. However, such an explosive increase has been often reported without high phytoplankton biomass during their spawning seasons, implying that other organic particles like detritus could be their food sources. This study intended to elucidate food source(s) of the COTs larvae fed by size-fractionated particulate organic matter (POM). The incubation experiments were conducted for two weeks at Sesoko Island, Okinawa, Japan in July 2015, and the specimens were collected at each developing stages for stable isotope analysis. Most larvae fed POM smaller than 20 μm developed to either the late bipinnaria or the early brachiolaria stage, and their stable isotope ratios shifted to the similar values to those of POM. The larvae without POM degraded within a week, and their isotopic value did not change from those of unfertilized eggs. On the other hand, the larvae fed POM smaller than 2 μm did not develop beyond the early brachiolaria stage but succeeded to survive for two weeks, and their isotopic ratios also became similar to those of POM. Our results indicated that organic particles other than phytoplankton seemed to contribute for the survival and development of COTs larvae.

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ANALYSIS OF THE DISTRIBUTION OF SPECIALIZED HERBIVOROUS REEF FISHES THROUGHOUT THE PACIFIC (Abstract ID: 30000 | Poster ID: 412)

The importance of niche width and specialization has been discussed for years, and the concepts are fundamental to ecological theory. Despite historic attention, questions still remain about the ways in which humans may be affecting specialization in coral reef communities. To explore this question, this meta-analysis examines how human impacts are shaping the composition of herbivorous reef fish assemblages on a Pacific-wide scale using fish abundance data for sites at over 40 islands collected by the Coral Reef Ecosystem Division (CRED) at the National Oceanic and Atmospheric Administration. Using diet data obtained from the literature, each species referred to as an herbivore by CRED is classified along a continuum of specialization. Comparing the abundance of fishes at each site to the human population within 200 km, as well as other variables (e.g., benthic cover, geographic location, human health and economic metrics), this study aims to determine which factors are most responsible for driving trends in the distribution and abundance of dietary specialists among herbivorous reef fishes in the Pacific. Understanding the characteristics of reef communities in which specialists thrive will assist in the identification of areas that may be particularly vulnerable to anthropogenic stressors.

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SPAWNING AGGREGATION OF WHITE-STREAKED GROUPER*EPINEPHELUS ONGUS*: SPATIAL DISTRIBUTION, ANNUAL VARIATION AND SEX-SPECIFIC DIFFERENCE IN ARRIVAL TIMING (Abstract ID: 27824)

Groupers (family Epinephelidae) are an impor¬tant fishery targets in coral reefs. *Epinephelus ongus* is a major fishery target that forms spawning aggregations at specific spawning grounds in an Okinawa coral reef. The aims of the present study were to investigate the spatial distribution, annual variation and sex-specific difference in arrival timing of this species. Underwater observations were conducted at a spawning ground in the spawning season (May between 2011 and 2015) in Yaeyama Islands, Okinawa. Monthly observations were also conducted during non-spawning seasons (between November 2012 and October 2013). Six to ten 30-min time-transects were set to cover the entire area of the spawning ground. Digital images of the substrates were simultaneously recorded in order to examine any relationships between fish density and environmental variables. Ten replicated 20 × 5 m line transects were established to clarify the daily changes in the male and female density. No individuals were found during monthly survey in non-spawning seasons. In contrast, high density of *E. ongus* was found in the spawning season. Clear spatial variations in the density were found. The highest number (53.6 individuals per 100 m2 in May 2011) was found in one time-transect (defined as "core site"). There were few significant relationships between fish density and environmental variables. Annual variations in fish density at the "core site" were found in May between 2011 and 2015. Males showed earlier arrival and stayed longer at the spawning ground compared to females.

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COMPARING DIFFERENTIAL DISEASE AND BLEACHING RESPONSES OF PACIFIC CORALS FROM LELEUVIA, FIJI AND MOOREA, FRENCH POLYNESIA (Abstract ID: 28531)

Increasing frequency and severity of coral bleaching events, often coupled with coral disease episodes, are degrading the health of coral reef ecosystems worldwide. Reefs will be differentially affected as coral taxa have varying susceptibilities to the two types of disturbance. To determine the relative susceptibility of different taxa over large spatial scales, coral bleaching and disease surveys were conducted at 10 sites in Leleuvia, Fiji (2013) and 9 sites in Moorea, French Polynesia (2015) during thermal anomalies. Overlapping photos were taken along belt transects at protected and fished sites in high and low energy settings to collect data on coral abundance and diversity while recording signs of stress such as bleaching and disease occurrence. Overall, Leleuvia showed slightly higher coral genera richness and diversity across habitats compared with Moorea. SIMPER (Similarity percentage) analysis clustered sites in Leleuvia in a single group and sites in Moorea in 2 major groups. Genera abundance within sites showed an

average similarity of 53.7% and 59.5% in Leleuvia and Moorea, respectively. However, between localities there was 52.1% dissimilarity. Average prevalence for bleaching and disease was slightly higher in Moorea (66%, 24.3%) than Leleuvia (8.2%, 7.1%). This distribution pattern was strongly influenced by Acropora, Montipora, Pocillopora, and Porites (cumulative contribution ~70%), indicating that these key genera have similar susceptibility to bleaching and disease over larger scales.

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REEF FISH ASSEMBLAGES IN FISHED AREAS WITH MPAS IN TOURIST AND NON-TOURIST DESTINATION SITES IN SOUTHERN MINDANAO, PHILIPPINES (Abstract ID: 29450)

MPAs have shown significant contribution in maintaining species diversity and in some cases supporting sustainable fisheries in the Philippines. Known tourist destinations sites in the country also found to contribute for the protection of endangered species (e.g. Tubbataha Reefs Natural Park, Palawan for Cheilinus undulatus) and sometimes reducing fisheries threats (e.g. EL Nido, Palawan) thereby help in maintaining reef integrity. But in some cases, tourists were the source of reef destruction and increase in fisheries harvest because of the clamour for sea foods. In this paper, we hypothesize that tourist and non-tourist destinations sites have no significant impact on reef fish assemblages. Results indicated that presence of MPAs at least under level 2 (effectively strengthened/enforced) occupying no less than 10% of the total reef area has a greater positive impact on the fish assemblages (i.e. high species diversity, >20mt/km2 of fish biomass) compared to areas with <10% reef area as MPA even with the presence of tourists. Impact of reef fisheries found to have lesser influence due to almost the same fishing pressure for the areas examined.

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STRENGTHENING LOCAL LINKS BETWEEN SCIENCE AND MANAGEMENT. BUILDING LOCAL STAKEHOLDERS INVOLVEMENT IN SCIENCE FOR CORAL REEF MANAGEMENT IN INDONESIA (Abstract ID: 29233)

Despite a plethora of coral reef studies in Indonesia, only a fraction of them are informing coral reef management. Thus, a rapid analysis was conducted in 2013 to identify the identify examples of success and failure and propose mechanisms for improvement. The analysis interviewed 75 respondents from 45 institutions and reviewed 5 marine national park strategic planning documents. We found that the need for science to support management is rarely expressed and often not well communicated by reef managers. The science generated in many cases is largely initiated or led by implementation partners (national/international NGOs or government projects). The study proposed a (1) strengthened structured collaboration between authorities, local strategic partners and implementation partners to identify information needs and develop appropriate studies; (2) its translation/integration into coral reef management; and (3) increased capacity building efforts. To ensure success, this needs to be supported by policies, regulations, and a clear exit strategy from implementation partners. A pilot project is being implemented in Buleleng Regency aiming at a development of coral reef science platform within the marine and fisheries agency (MFA) since 2014. In this early phase, MFA coordinate efforts from two implementation partners and local universities to identify and implement strategic coral reef research, provide expert support, and develop management recommendations based on sound science. The lessons from Buleleng would be used to strengthen the model and apply it to other places.

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ARE ZANZIBAR'S REEFS UNDERGOING ECOLOGICAL CHANGE? FORAMINIFERA BIO-INDICATORS FOR MONITORING AND ASSESSMENT OF REEF ECOSYSTEMS IN THE WESTERN INDIAN OCEAN (Abstract ID: 28602)

The reefs of the Zanzibar Archipelago contain high biodiversity taxa and are key ecosystem service providers and resource base generating fisheries and tourist revenue for subsistence-based coastal communities. Zanzibar's reefs remain some of the least studied in the world and face increasing pressure from rapid coastal expansion of urban areas, development of tourist facilities, overharvesting and daily boat/tourist visitations. Here, we provide the first foraminifer community data; their contribution to reef carbonate production; and an assessment of the response of foraminifers to untreated urban wastewater pollution from Stone Town in nearby fringing reefs (Changuu, Bawe and Chumbe). Overall, we find: a high diversity assemblage (130 species) dominated by abundant key symbiont-bearing, large benthic foraminifers (LBFs), particularly Amphistegina spp.; high FORAM Index values ranging from 5.3 to 9.1; and a contribution of as much as 40 to 90 percent to carbonate sand production. Communities at Chumbe MPI are more stable than Changuu Reef, which has higher daily visitations. The concentration of nutrients derived from untreated wastewater from Stone Town is variable but low (< 0.8 umolL-1). However, an increase in urchins and predators (COTS) in reefs closest to Stone Town indicates continuous monitoring and management of benthic communities and water quality changes is needed to ensure long-term protection of Zanzibar's ecological integrity and natural resources. Foraminifera offer a good cost-effective monitoring and management tool for regular, effective assessments.
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IMPACTS OF THERMAL STRESS ON THE PORITES SPP. CORAL-POPULATION DYNAMICS IN A SMALL PHILIPPINE EMBAYMENT (Abstract ID: 29056)

The increasing frequency of thermal stress has affected reefs in the tropical seas causing mass coral bleaching. In 2010 and 2013 the western Philippines experienced mass coral bleaching that affected the Porites coral populations, a coral considered to be resistant to many stressors and disturbances. In this study, we examine vital rates of Porites in a small bay in the western Philippines in order to evaluate the changes in the size structure before, during and after the 2010 bleaching event (i.e. the 2013). Photographic censuses were made from 2009-2013 for 658 Porites colonies from three fixed plots in each of four stations in the bay. Two of the four stations with bigger and denser colonies showed significant differences in the size structure of Porites before the 2010 bleaching and one station after the 2013 bleaching but not after the 2010 bleaching. The dominance of small colonies in all the stations was not due to recruitment but due to partial mortality and fission. The transition matrices indicated that the Porites population have declining population growth rates (lambda=<1). This suggests that the population was already in decline before the 2010 bleaching and exhibited further decline after the 2013 bleaching event. To reduce the vulnerability of Porites populations in the bay it would require reducing exacerbating threats in the face of more frequent thermal stress. This is to allow establishment of new resistant and persistent individuals into the population in order to enhance survivorship.

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MANAGING CORAL REEFS FOR FISHERIES AND ECOSYSTEM RESILIENCE OBJECTIVES (Abstract ID: 27894)

On coral reefs, little work has examined the relative effects of fishing and other drivers, such as habitat change, on ecological fisheries indicators. In light of increasing habitat degradation, this lack of understanding limits the usefulness of indicators for monitoring the effect of fishery management actions. We examined the relative influences of a proxy of fishing pressure and the benthic habitat on 17 indicators that characterise attributes of the fish community important for fishery yields. We found that both habitat and fishing influenced indicators, but habitat effects were particularly strong. This knowledge provides managers with the capacity to implement an array of complementary management actions targeted at maintaining reefs in a coral-dominated state. Critically, these actions may be beneficial both for sustaining ecosystem structure and function, and for supporting characteristics of the fish community that underpin fisheries production. We then explored potentially useful management actions in this context. We examined the relative importance of herbivore biomass, functional diversity and size composition in supporting habitat recovery. We found that having both a diversity of herbivore functions and sizes was important for recovery. Maintaining a wide range of herbivore sizes requires that no size-class is disproportionately depleted by fishing. Balanced harvesting, where species are all fished in proportion to their potential production, would help achieve this and support both fisheries and ecosystem resilience outcomes.

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UNEXPECTED CONTROLS ON REEF-BUILDING PROPERTIES OF CORALLINE ALGA POROLITHON ONKODES (Abstract ID: 29712)

Crustose coralline algae (CCA) play a vital role in structural reef-building. They form thick, hard crusts that binds reef skeletal material to form new reef substrate and can build extensive protective algal rims. Porolithon onkodes is the dominant species in the shallow high-energy environment of the fore reef. It has been presumed that their capacity to form a durable crust capable of persisting in the face of incessant high-energy waves is due to their calcified cell walls. We found that unexpectedly, it is secondary mineralization processes that enable the development of their thick, tough crusts. Using nanoindentation, a materials engineering analytical technique, to test the hardness and fracture toughness of the CCA we found that the presence of the mineral dolomite lining the cells, transforms the crust to a super-tough, fracture resistant material. In contrast, crusts without this extra mineral exhibited poor fracture resistance. A most surprising result was the role of endolithic erosive bacterial activity. Usually this is considered a destructive force, however, the nanoindentation testing revealed this to be a key constructive process in reef-building. The findings from this study, together with recently discovered chemical and bacterial erosion resistant properties of CCA dolomite, demonstrate that dolomite formation within P. onkodes is an essential process for modern structural reef development and persistence. Experimental work suggests that dolomite will continue to provide this reef-building service as CO2 rises.

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RECORD OF CORAL REEFS STRUCTURAL CHANGES, CORAL BLEACHING IMPACTS AND RESILIENCE FACING CLIMATE CHANGE EFFECTS AT THE SIAN KAAN BIOSPHERE RESERVE (Abstract ID: 29833)

According to the last publication of the Caribbean Coral Reefs Status, three quarters of the locations studied until 2012 reduce their coral cover to half since 1970. In the other hand macroalgae triple its cover, finding in the latest years reefs in severe degradation. In the Mexican Caribbean Sian ka'an Biosphere Reserve (SKBR) is one of the largest areas in Mexico including coral reefs. A first description of the reef structure and condition was done in 1993. Some other studies evaluated the area after this date, however it was until 2011 when an specific monitoring program was implemented with monitoring sites at the back reef, shallow and deep fore reef. Here we analyzed the structural changes found in the reefs of the SKBR from 1993 to 2011 and changes in the reef ecosystem condition from 2011 to 2015. Although coral cover in 2015 register 16.9% without significant changes since 2011, results showed a reduction of coral builders that use to be dominant; it also showed an increase of macroalgae and coralline algae, increase of diseases presence and increase of bleaching episodes related with climatic anomalies. During 2013 recent mortaliy increased in sites near to the bays due to an atypical rainfall. Bleaching during 2015 (August-November) showed an increased in extent and intensity affecting more tan 50% of the coral colonies registered in all sites monitored. With five years data of the monitoring program, including water quality information, we were also able to run a resilience analysis for the monitoring sites for management porpouses.
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INDIGENOUS CLASSIFICATION AND UTILIZATION OF THE RED SEA BLACK CORAL (Abstract ID: 28331)

Precious materials, such as red and black coral, have gained in value because they are natural organic resources living in the deep-sea environment, which, for a long time, have presented humans with considerable difficulties in collecting them. Despite their economic and cultural importance, little is known about the basic biology and ecology of black corals (Cnidaria: Anthozoa: Hexacorallia: Antipatharia) because most species inhabit deeper-water environments (>50 m), which are logistically challenging to study (Wagner et al. 2012). In the Red Sea area, black coral has been known to, and valued by, local people for a considerable period. The axial skeleton of black coral is formed by a brown or black extremely hard proteinaceous material which, when cut and polished, is used for making jewelry and prayer beads (Vine 1986). Prayer beads made of black coral are known as "yusr", an Arabic word meaning "ease" or "well-being". Based on my field study in Sinai, Egypt, fishermen of the Red Sea viewed black corals as living creatures because they wrapped themselves around the men when they moved close to the coral. The fishermen shaved their bodies and removed all their clothes before diving and recited the "basmalah" when cutting the coral. Humans believed they could only reach the precious material, and overcome their fear of water, when they invoked divine protection. There is an undersea world that lies out of reach of the knowledge and activities of helpless humans, even though it is included within the range of marine resource conservation or ecosystem-based management.
http://akitauinfo.akita-u.ac.jp/html/100000347_ja.html

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THE XL CATLIN SEAVIEW SURVEY: MEASURING BLEACHING AND COMMUNITY RESPONSE IN HAWAII IN 2015 WITH HIGH-DEFINITION IMAGING AND SEMI-AUTOMATED IMAGE PROCESSING (Abstract ID: 28886)

Coral reefs worldwide are suffering dramatic declines, with an estimated 40% of coral reef habitat degraded within the last 50 years due to a suite of factors, including pollution, overfishing, destructive fishing and climate change. This degradation will affect the ~500 million people globally who utilize coral reefs for food, tourism income and coastal protection, along with the potential future losses to the still partially unknown biodiversity of these ecosystems. The XL Catlin Seaview Survey is a multiyear program creating a baseline record of coral community composition over 150 worldwide coral reef locations, using multi-camera, high-resolution, panoramic underwater imaging. These images are processed by a novel, computer-vision driven, automated benthic image analysis system capable of producing summary statistics of population and community composition in less time than manual annotation. We deployed this camera system in Maui, Hawaii to measure community response and bleaching rates before and during the autumn 2015 bleaching event, and will present a summary of these methods and findings.
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CORAL RESTORATION FOUNDATION: A 15 YEAR STUDY IN BUILDING A LARGE SCALE, REPLICABLE RESTORATION MODEL (Abstract ID: 29957)

Coral reef ecosystems are declining worldwide due, ostensibly, to direct and indirect anthropogenic stressors. The Caribbean reef biota's decline has been further accelerated by loss of keystone species, principally Diadema antilarum, widespread coral disease, and successive, regional bleaching events, each confounding the accelerated loss of crucial reef building corals: Acropora sp. Although water quality in many regions remains suitable for coral growth and reef development, reef ecosystems continue to collapse – or not recover – due to low coral recruitment or an inability for new recruits to become established. During the last 20 years various coral propagation and reef restoration techniques have been explored and refined. Some of these projects led to the development of community-based restoration programs that have had varying degrees of success and persistence. The transference of any such project from proof-of-principal to a regional restoration program faces challenges of scalability and sustainability. At the Coral Restoration Foundation we set out to develop a large scale, community based program. Integrating restoration, science and education programs we have built a model that is scalable, suitable of generating and planting large numbers of corals, and integrates community-level volunteers and partners in an active, self-sustaining manner. Now, 15 years following our origin, we present a complete overview of our methodologies, lessons learned, successes and how the model has been adopted in various partnerships and stand-alone programs internationally.
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TROPICAL ECOTOXICOLOGY FOR OIL AND GAS (Abstract ID: 29243)

Risks posed by oil spills to coral reefs are difficult to evaluate, primarily due to the absence of studies adequately assessing toxicity to relevant reef species. Furthermore, comparison of the available data is impractical owing to fundamental inter-study differences including: oil types; inclusion of chemical dispersants; methods of preparing water accommodated fractions; durations of exposure and accurate quantification of toxic aromatic hydrocarbons. Here we present a model ecotoxicological workflow for laboratory exposures of tropical reef species to oil and gas contaminants for use by regulators, managers and industry. To illustrate this approach, a series of experiments with coral and sponge larvae is presented to compare the toxicity of light crude oil in the presence and absence of UV

and to compare the toxicity of a range of chemical dispersants to coral larvae. We also present the development of species sensitivity distributions using tropical taxa to progress water quality guidelines for oil and gas contaminants. Whilst traditional ecotoxicology incorporates ecologically relevant endpoints including reproduction, growth and mortality; we show how molecular level responses are also emerging as sensitive indicators of exposure impact. With increasing oil and gas extraction, shipping and coastal development, incorporation of standardised and relevant ecotoxicological methods will be critical to inform spatial risk assessments, management decisions, guidelines, policy development and ultimately the protection of high conservation value coral reefs.

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CORAL REEF RESTORATION THROUGH MANAGEMENT OF THE ALIEN INVASIVE THROUGH THE USE OF MECHANICAL REMOVAL AND BIO-CONTROL EFFORTS (Abstract ID: 28944 | Poster ID: 472)

For several decades, invasive macroalgae (Acanthophora spicifera, Gracilaria salicornia, Kappaphycus spp., Eucheuma denticulatum) have posed a serious threat to coral reefs in Kaneohe Bay, Hawaii. To address this ecological threat a consortium of researchers and managers developed a novel approach to control invasive algae by combining mechanical removal and biocontrol techniques. Invasive algae are manually removed by divers equipped with an underwater vacuum system. Then, hatchery-raised native sea urchins (Tripneustes gratilla) are outplanted to graze remaining holdfasts and control algae re-growth. These techniques have been evaluated at the experimental level, but have not been thoroughly tested at the reef-wide scale as a management technique. Here, we conducted benthic surveys on two patch reefs and two control reefs in Kaneohe Bay and tested the effectiveness of mechanical removal and biocontrol of invasive algae in a natural reef ecosystem. We analyzed the change in percent cover of invasive algae before (2011-2012) and after (2014) algae removal and urchin outplanting. Mechanical removal and biocontrol reduced invasive algae percent cover by 85%. Our results show that mechanical removal in combination with sea urchin biocontrol is an effective management approach for controlling invasive algae at the reef-wide scale.
http://dlnr.hawaii.gov/ais/invasivealgae/supersucker/

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PELAGIC BIOGEOCHEMISTRY OF SHALLOW CORAL REEFS IS DISTINCT FROM THE SURROUNDING OCEAN (Abstract ID: 29864)

The persistence of productive coral reefs in relatively oligotrophic waters of the surface tropical oceans implies that reef ecosystems retain and recycle nutrients such as nitrogen, phosphorus and organic carbon. Describing the nutrient regime of reef waters is important for understanding reef metabolism and productivity, but measuring and differentiating biogeochemical parameters of reef waters from the surrounding ocean requires high resolution sampling and analytical precision. We used an unprecedented opportunity to conduct a high-resolution synoptic oceanographic profile survey of the offshore and nearshore reef waters surrounding Mo'orea, French Polynesia to couple a suite of biogeochemical measurements with physical oceanographic parameters and detailed bathymetric mapping. We established consistently significant differences between backreef and offshore surface waters in a suite of biogeochemical parameters, with elevated concentrations of inorganic nutrients (nitrate, ammonium and phosphate) and depleted concentrations of dissolved organic carbon and bacterioplankton in the reef water column. We also show that reefs maintain a unique signature of fluorescent dissolved organic matter composition enriched in humic and protein components. By sampling the circumference of the island we captured onshore-offshore patterns across very different wave energy regimes and benthic community structures, and we present our biogeochemical data in the context of both synoptic and long term understanding of the physical forcing and community ecology of reefs around Mo'orea.

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INTEGRATION AND ALLOMETRY CONSTRAIN CARIBBEAN OCTOCORAL MORPHOLOGY (Abstract ID: 28828)

As stony corals continue to decline in abundance, there is interest in the potential of other macroinvertebrates, such as octocorals, to play a stronger role in the structure and function of future reefs. While it is well known that arborescent octocorals exhibit complex geometries with variation at the polyp, branch, and colony level, the factors constraining colony morphology remain unclear. To examine the role of integration among traits and allometry in controlling variation within and among Caribbean octocorals species, we compared five morphological traits (colony height, branch length, branch thickness, number of branches, and polyp density) among eight species of the common octocoral *Eunicea*. Principal components analysis (PCA) revealed that some traits were tightly correlated, with variation in morphology between species constrained to a linear gradient. This gradient was comprised in one direction of species with many, thin, short branches with a high polyp density, and in the other direction with species having few, long, thick branches with a low polyp density. Interestingly, this gradient was independent of the effects of colony size on octocoral architecture. Morphological traits either didn't scale with colony size (e.g., polyp density, branch thickness) or scaled allometrically with size in such a way that the differences in morphology between species were maintained along the aforementioned gradient. Differential scaling of traits among species may drive species coexistence by allowing species to exploit different resources in the same place.

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CONTINUOUS IMAGING FLOW CYTOMETER – FLOWCAM - FOR THE STUDY OF PHYTOPLANKTON (Abstract ID: 29617 | Poster ID: 528)

Responding to the need for the "rapid counting and measurement of individual plankton cells in natural populations", researchers at the Bigelow Laboratory for Ocean Sciences in 1999 developed an imaging flow cytometer (FlowCam) designed specifically to support aquatic microbial research. Over the past 15 years over 300 FlowCAMs in 50+ countries have been put to use for the purpose of the study and monitoring of microorganisms in both fresh and marine systems. Building upon advances in technology, input from the user community, and expanded resources, engineers at Fluid Imaging Technologies, manufacturer of the FlowCAM, have transformed the FlowCAM of 1999, and now build an instrument that is vastly improved when compared to the first unit built. We present here a brief evolution of the FlowCam, focusing on the current state of the instrument's technology, with particular emphasis on new capabilities of the FlowCam's software to with regard to image recognition, classification of taxa, and estimation of plankton biovolume.
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SEAFOOD CONSUMPTION PATTERNS IN FISHERY-DEPENDENT HUMAN COMMUNITIES: ECOLOGICAL RELATIONSHIPS IN A CORAL REEF SOCIO-ECOLOGICAL SYSTEM (Abstract ID: 30038)

The human inhabitants of Falalop, Asor, Mogmog and Federai (Ulithi Atoll, Yap State, Federated States of Micronesia) enjoy differing levels of access to fishable reefs and imported goods. The health of their coral reefs and the abundance and community composition of associated fishes also vary. We sought a better understanding of the relationship between the status of these resources and fishing activities on these four islands. We also sought insight into reports of food insecurity. To complement underwater surveys of reef fish populations and fishery landings data, we tracked seafood consumption in 53 households over a 28 day period using a calendar that enabled participants to record meals at which seafood was consumed, the seafood source, fishing activity and the distribution of seafood captured but not consumed by that household (i.e., shared with other households or shipped off the atoll). We found significant differences in the frequency of seafood consumption within and between communities at least partially attributable to the health of community-controlled reefs and their associated fish stocks. The health of these resources and their ease of access were reflected in patterns of seafood consumption as well as the frequency and characteristics of fishing activities. Fishing prowess and access to resources, but not household size, affected sharing of resources. Coral health, fish abundance, and food security co-vary on Ulithi Atoll; seafood consumption estimates offer a powerful new perspective on the ecological relationship between reefs and human communities.

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THE STRUCTURE OF FISH ASSEMBLAGES ON RESTORED AND UN-RESTORED CORAL REEF HABITATS IMPACTED BY SHIP GROUNDINGS (Abstract ID: 29929)

We conducted an experimental study using both B.A.C.E. and comparative designs in order to evaluate how fish assemblages responded to active coral reef restoration work at two large ship grounding sites in Guayanilla, Puerto Rico. Restoration of the impacted coral reef habitat involved out-planting of*Acropora cervicornis* from nurseries to restore areas where the reef topography was flattened. Also emergency restoration was conducted to salvage detached corals, octocorals and sponges to recover lost habitat from groundings. Data on reef fish density, species diversity and size structure were collected from four experimental treatments: *A. cervicornis* outplants, emergency restoration areas, non-restored impacted areas and reference natural reef habitat including A. cervicornis thickets. The benthic community at each treatment was sampled to evaluate correlations between the fish assemblage, sessile biota and rugosity. Fish assemblages within restoration sites were more similar to reference sites than un-restored treatments. *Acropora cervicornis* restoration sites exhibited a temporal change in fish habitat utilization and had a higher relative abundance of early juvenile life stages of reef fishes. These results provide information for understanding the dynamics of reef fish habitat value related to coral reef restoration efforts.

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APPLICATION OF ACOUSTIC TELEMETRY TO ADVANCE SCIENTIFIC UNDERSTANDING AND INFORM MANAGEMENT OF SPECIES THAT FORM SPAWNING AGGREGATIONS IN THE US VIRGIN ISLANDS (Abstract ID: 29527)

Acoustic telemetry has provided new insights into the movements of aquatic organisms. Drivers of animal movements can include foraging, reproduction and ontogeny that can encompass multiple habitats and various spatial scales. Environmental variability is a fourth driver of movement that has become more important as climate change intensifies. This paper reports on the dynamic application of acoustic telemetry as an essential tool to discover novel behaviours that advance scientific understanding and inform management. Emphasis will be placed on several fish families that migrate to spawning aggregation sites or forage across various habitats (i.e. Epinephelidae, Lutjanidae, Megalopidae, Scaridae) and how acute environmental change may modify behavioural patterns.

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MORE THAN JUST A PRETTY MANTLE: THE ECOLOGICAL SIGNIFICANCE OF GIANT CLAMS IN CORAL REEF ECOSYSTEMS (Abstract ID: 28243)

Giant clams are large and colourful bivalves closely associated with Indo-Pacific coral reefs. They are thought to play various ecological roles but these have not yet been fully elucidated. In this study, we show how giant clams are important providers of food and shelter, and function as reef builders and shapers. Giant clam tissues are attractive to predators and scavengers, while opportunistic feeders exploit their discharges of live zooxanthellae, faeces and gametes. The shells of giant clams provide hard substrate for colonization by epibionts, while various commensal and ectoparasitic organisms live within their mantle cavities. Populations of giant clams can enhance the topographic relief of reefs, act as reservoirs of zooxanthellae, and potentially counteract eutrophication via water filtering. Lastly, giant clams can produce large quantities of calcium carbonate shell material that eventually becomes part of the reef framework. As with many benthic species, giant clams are facing pressures of overfishing and habitat loss, resulting in extirpations that are likely to affect coral reefs negatively. Identifying the ecological roles of giant clams is an important step in strengthening the case for their conservation.

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SYMBIODINIUM DIVERSITY IN PORITES COMPRESSA FOLLOWING A NATURAL BLEACHING EVENT (Abstract ID: 29747 | Poster ID: 356)

Climate change has led to increases in coral bleaching worldwide. The question of why corals expel their symbiotic zooxanthellae (Symbiodinium) has been studied from the perspective of the coral host as well as the symbiont. While progress has been made toward understanding the physiological and cellular mechanisms that cause bleaching, Next-generation sequencing (NGS) permits further investigation of genetic explanations for variations in bleaching response across the entire genome. This work is focused on identifying genetic factors from the coral genome that are associated with bleaching variation, as well as the composition of Symbiodinium communities within corals during and after bleaching. To address the question of Symbiodinium clade composition, we compared Symbiodinium in colonies of Porites compressa that varied in their response during the 2014 bleaching event in Hawaii. Although other species of Porites have been shown to host thermally-tolerant clade D zooxanthellae, previous studies have found that P. compressa only host a single clade (C), even among colonies in habitats that have a history of high temperatures. For this work, we genetically analyzed colonies of P. compressa sampled from October 2014 through November 2015 from four sites in the Main Hawaiian Islands. Our approach is to use restriction site-associated DNA sequencing (RADseq) to analyze genomes of the coral holobiont and identify symbiont clades, and we will discuss progress in using NGS to characterize symbiont diversity among colonies with different bleaching phenotypes.

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TEMPERATURE AND SALINITY EFFECTS ON THE ONSET OF SYMBIOSIS BETWEEN *ACROPORA VALIDA* AND VARIOUS SUBCLADES OF*SYMBIODINIUM* (Abstract ID: 30017)

Larvae of most broadcasting corals do not contain symbionts. They have to establish symbiosis by uptaking symbionts from the environment. This process is likely to be affected by environmental factors. To study the possible consequences of global climate change on coral-algal symbiosis establishment, *Acropora valida* recruits were exposed to different temperatures (24, 27, 30 and 32°C), salinities (22, 27 and 32psu) and symbiont treatments (subclades C1, C15 and D symbionts). The success of symbiosis establishment was recorded in terms of infection percentage and visual ranking on symbiont density. Results showed that all the three symbiont types could infect *A. valida* recruits, with symbiont D showing the highest infection percentage in the first three weeks, though only C1 could be found in local adult *A. valida*. High temperature impaired infection ability of C1 and C15 but not D. Lowered salinities showed little effect on infection percentage. Recruit mortality was also monitored. D-infected recruits showed no significant difference in mortality from C1-infected recruits under elevated temperatures. Clade D symbiont has been reported to be less photosynthetically efficient and contributed to lower growth rate in coral juveniles. So the result of this experiment suggested that increasing seawater temperature may drive the coral recruits to form symbiosis with less favorable symbionts and thus affect the growth of the next generations of corals in the future. This project is supported by RGC-GRF 460013.

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BIODIVERSITY OF GIANT CLAMS (TRIDACNIDAE) IN THE SPERMONDE ARCHIPELAGO, SOUTH SULAWESI, INDONESIA (Abstract ID: 29738 | Poster ID: 52)

Wild population of clams under family of Tridacnidae has been declined and even gone to extinct in some areas of Indonesian water. For that reason, there is a strong need to determine its current condition in the Spermonde Archipelago. The study was conducted on 11 islands that represent three zones of Spermonde Archipelago using Belt Transect method. The results are presented descriptively in the form of tables, figures and graphs. There are four species of clams (Tridacnidae) found in the research area, namely Tridacna crocea, T. maxima, T. squamosa, and Hippopus porcellanus. The highest density was found on the island of Lumu-Lumu, Barrang Lompo, and Bone Tambung respectively. The shell size of T. crocea found dominantly in a range of 1-3 cm and 3-6 cm. In contrary, T. maxima are dominated by population with shell size 7-10 cm and 4-6 cm, while the phase of juvenile shell size 1-3 cm and 11 cm in the population were found in low density. T. squamosa population is dominated by larger shell size (70-20 cm) while size 1-3 cm is rarely found. This implies that the rate of recruitment and reproduction of T. squamosa is very small, which most probably caused by the reduction of adult population in the wild.

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DISEASE ECOLOGY AND TRANSMISSION PATTERN: A CASE STUDY OF BROWN BAND AND BLACK BAND DISEASE ON THE GREAT BARRIER REEF (Abstract ID: 28021)

Managing diseases in nature requires understanding how pathogens are transmitted among hosts. We summarise field and aquarium studies aimed at understanding transmission patterns and vectors of black band disease (BBD)and brown band disease (BrB), two coral diseases on the Great Barrier Reef. In aquarium studies testing the vector potential of two corallivores, the butterflyfish *Chaetodon plebeius* and the snail *Drupella* sp, we found that chaetodontids did not transmit either disease, even when fish fed directly on both infected and healthy nubbins for extended periods of time. In contrast,*Drupella* transmitted BrB to healthy corals in 40% of cases; however, the snail was unable to transmit BBD. Although we observed selective predation by chaetodonids on BBD and BrB lesions, we found no evidence that removal of pathogens by butterflyfish decreased disease progression rates. These results demonstrate that fish are unlikely to influence the dynamics of these diseases, either by slowing disease progression rates or by increasing pathogen transmission among corals. *Drupella* snails however, have the potential to transmit BrB between coral colonies in the field, but not BBD. A 2-year field study of temporal patterns in the spatial distributions of BBD and BrB confirmed that both diseases behaved as infectious diseases, clustering in restricted areas of the available space. Collectively these results indicate that pathogens are transmitted from a source colony to adjacent hosts, possibly with the help of vectors such as *Drupella* snails.

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LEPTASTREA PURPUREA: A POSSIBLE MODEL ORGANISM FOR CORAL REPRODUCTION AND PHYSIOLOGY (Abstract ID: 28762 | Poster ID: 173)

Sexually produced larvae are used in various fields of coral research. Because the vast majority of scleractinians reproduces only once or a few times a year and an ex-situ spawning induction is still very hard to achieve, obtaining planula larvae is still very labor intensive. Larvae of brooding corals can be used but are oftentimes clonal and differ in various traits, e.g. settlement behavior, from most spawning corals. Other cnidarians, such as Aiptasia spp. have been substituting scleractinians as model organisms in coral research. Admittedly, the transferability of conclusions obtained from these species can be questionable. This study examines the potential of Leptastrea purpurea as a reliable source of larvae for coral research. L. purpurea is a small (approx. 10 cm) encrusting faviid coral that occurs from the Red Sea to Easter Island. It is common on reef flats and can also be found in depths of up to 30 m. Larval output throughout the year as well a1s settlement behavior of planulae was investigated with corals from Guam. Our results show that L. purpurea releases larvae in a nonperiodic manner allowing permanent access to planulae. The settlement behavior of L. purpurea is similar to many spawning species which increases the transferability of conclusions. We discuss the aptitude of L. purpurea for research on scleractinian physiology, reproduction and ecology and conclude that L. purpurea is an adequate candidate as model organism that could accelerate progress in many fields of coral research.
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BULELENG MARINE MANAGE AREAS NETWORK DEVELOPMENT. JUST DO IT. LESSON ON HOW TO INITIATE MARINE MANAGE AREA (MMA) WITH LOCAL RESOURCES (Abstract ID: 28672 | Poster ID: 679)

Buleleng Regency is working on establishing an MMA network of 14,000 ha. The network was design to include already established local MMAs : Pemuteran, Les, Bondalem, Tejakula, Penuktukan villages. Local stakeholders that have specific interest on conservation led the initial development of the MMAs: the tourism sector in Pemuteran, and fishing communities in other villages, in partnership with NGOs. It is important to note that the MMAs were initiated under significant resource support from the communities. The NGOs mainly focused on structuring the community's work, building collaboration within them, and bridging them to strategic partners. The NGOs also connect themself to share program and resources. Buleleng government has been embracing the effort consistently over time with policy support, financial resources, and dedicated staffs. They actively involved MMA's community management bodies in the process. This builds a significant leverage to the conservation. Interests from community are increasing, more partners are connected and supports are rising. Third party funding for Tejakula were US0$ in 2008. In 2009, it raised to US$39,917. In 2016, at least 8 NGOs are partnering with government and local community to support the MMA network development. Buleleng has shown that to develop an MMA, we can rely on local resources. This is not only economically efficient, but also create independency. Thus, it gives a higher assurance of a development of a strong and sustainable adaptive co management system.

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DIVERSITY OF GORGONIANS AND GAMETE DEVELOPMENT OF GORGONIAN, DICHOTELLA GEMMACEA IN THE UPPER GULF OF THAILAND (Abstract ID: 29681 | Poster ID: 53)

Gorgonian is one of the most abundant organisms, and has an important role in coral reef ecosystem. In this study, the diversity of gorgonians at Laem Pu Chao, Amphoe Sattahip, Chon Buri Province in the upper Gulf of Thailand was investigated. In addition, the gamete development of Dichotella gemmacea was observed. The results showed that a total of nine genera of gorgonians, i.e. Ctenocella, Dichotella, Echinogorgia, Euplexaura, Junceella, Melithaea, Menella, Rumphella, and Subergorgia were found in the area. From the field observations, the gametes of Dichotella gemmacea in all stages were found year around. However, high maturity stages were recorded from August to September.
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SURVIVABILITY OF JUVENILE CORAL IN THE VICINITY OF A SHALLOW WATER THERMAL VENT (Abstract ID: 28989 | Poster ID: 375)

Ocean acidification is a decrease in pH and carbonate ion concentration of the seawater as a response to rising atmospheric carbon dioxide, which expected to have a negative effect on the reef-building corals and calcifying marine organisms. Thus, we evaluated the growth characteristic of juvenile corals in the naturally acidified water of a thermal vent at Pulau Weh, Indonesia. The dominant juvenile corals that were selected for observation were from the genera Acropora, Pocillopora and Porites. The field survey showed a general decrease in the growth and skeletal structure along a decreasing pH gradient, whereby significant effect were observed among juvenile corals that were exposed to pH value 7.7. Growth rate of juvenile corals decreased 20-40% over the study period at the lowered pH condition compared to control condition. The study suggests that juvenile corals at acidified water record a slower growth and a porous skeletal structure. However both field and laboratory experiments will provide a better insight on the susceptibility of coral facing the changing climate particularly ocean acidification.

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A RESEARCH FRAMEWORK FOR RESOLVING NICHE DIFFERENTIATION AND SPECIALISATION IN SYMBIODINIUM (Abstract ID: 28879)

The genus Symbiodinium comprises a group of free-living marine dinoflagellate species that have radiated extensively into an endosymbiotic niche. Symbiodinium act as corals' 'solar cells' and ultimately supply a significant portion of all energy used in the formation of tropical reef ecosystems. Vast genetic diversity, heterogeneous populations in symbiosis, and cryptic stages in the life-history (e.g. free-living, sexual reproduction, and endolith formation) make Symbiodinium exceptionally difficult to study and hence coral-Symbiodinium life history dynamics are not currently considered within models of reef-health. Using previously unpublished data of Symbiodinium biology, including: genome size estimation; cell viability ex hospite; interaction with microhabitats as free-living cells; and identification of key traits unique to cryptic stages of the life history; we propose a framework critically needed to expand perception of Symbiodinium functional biology. This new framework will classify variations in life history (e.g. obligate symbiont, transiently free-living, concurrently free-living, or exclusively free-living), thus providing context for specialisation in symbiosis, or alternatively, selection pressures that promote alternative, ex hospite niches of Symbiodinium cells via their free-living phase. Detecting where Symbiodinium lineages are positioned on these evolutionary pathways is ultimately needed to attain a system-wide epidemiology for reefs facing climate change and will isolate 'best candidates' for assisted evolution and reef restoration-based management.
http://www.uts.edu.au/research-and-teaching/our-research/climate-change-cluster

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DIVERSITY AND EXTREMELY HIGH ABUNDANCE OF PICOCYANOBACTERIA IN THE TROPICAL LAGOON WATERS OF TONGA (Abstract ID: 29963 | Poster ID: 49)

Flow cytometry enumeration method and high-throughput bar-coded pyrosequencing technique for 16S-23S internal transcribed spacer (ITS) sequences were applied to elucidate spatial changes of picocyanobacterial abundance and diversity in the near

coastal tropical waters of Tonga in November 2013. The samples were collected from 57 stations around Tongatapu Island, main island of Tonga. In most stations, *Synechococcus*was the most abundant picophytoplankton, ranging widely from 0.03 to 150.2 x $10^4$ cells/ml. On the contrary, *Prochlorococcus* abundances ranged from n.d. (not detected) to 7.2 x $10^4$cells/ml. The extremely high *Synechococcus*abundances over $10^6$cells/ml at the upper bay around Fanga'uta Lagoon indicated that there is huge nutrient input from rural and agricultural area to support the high phytoplankton biomass. In addition, dominance of*Synechococcus*clades II, III and VIII in this area suggested that they also actively grow in high nutrient conditions as well, despite clades II and III were known to be dominant in relatively oligotrophic coastal waters. However, in most lagoon waters, *Prochlorococcus* was not detected due to the oligotrophic nature of *Prochlorococcus*. These results suggested that habitat characteristics of the tropical lagoon drive variability in picocyanobacterial diversity. Such tropical lagoon environment might provide an appropriate location for carrying out studies on ecological niche of picocyanobacterial ecotypes.

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ARAGONITE SATURATION IN A FRINGING REEF IS STRONGLY INFLUENCED BY OCEANIC CONDITIONS: CABO PULMO, MÉXICO. (Abstract ID: 29724 | Poster ID: 378)

Ocean acidification studies indicate that aragonite saturation (Ωar) will decrease with potential negative effects on reef ecosystems. Reef morphology controls the residence time of seawater, allowing physical or biological control over CO2-system. We test if the CO2-system in a fringing reef is controlled by ocean conditions. Monthly discrete samples were collected from September 2012 to August 2013, pH and dissolved inorganic carbon were used to calculate Ωar. A SeapHOx sensor was deployed in November 2013 to June 2014, at 15m depth and 30min sampling rate. pH was calibrated with discrete samples. This reef has direct communication with ocean, so discrete sampling showed that advection controlled the CO2-system, with presence of Gulf of California Water (GCW,Ωar=2.8±0.1) during winter and Tropical Surface Water (TSW,Ωar=3.2±0.3)the rest of the year. Optimal conditions for coral calcification occur in summer, with 0.5 Ωar between seasons. Sensor data showed a similar seasonal pattern plus the California Current Water, were water-mass intrusions corresponded to oceanic processes. TSW-GCW transition caused a 0.54Ωar decrease. Seasonal presence of water masses indicate a strong oceanic influence, and along with tidal forcing, not allowed to detect dissolution-calcification signals. Our results suggest that: a) fringing reefs might suffer the effects of acidification compared with barrier reefs which modify seawater; b) coral communities in fringing reefs are adapted to a variable Ωar, so it is feasible that predictions of decreasing pH have no direct effect on calcification.

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THE NEURAL CIRCUITRY OF PAIR BONDING IN A COMMON BUTTERFLYFISH, CHAETODON LUNULATUS (Abstract ID: 27772 | Poster ID: 505)

While the adaptive significance of coral reef fish social systems is well explored, little is known about their neural basis. Here, we investigated the neurobiology of pair bonding in the monogamous butterflyfish, *Chaetodon lunulatus*. We focused on four neurochemical-receptor systems involved in mammalian pair bonding, including the oxytocin-like receptor, isotocin (ITR); arginine vasotocin V1a receptor (V1aR), dopamine D1 and D2 receptors (D1R, D2R); and the mu-opioid receptor (MOR). To functionally test the involvement of these receptors in promoting pair bonding, we treated paired males with receptor antagonists, which blocked pair bonding behavior. To then examine what brain regions might be involved in this effect, we compared gene expression of these receptors within brain regions between paired and solitary individuals. We found that pair bonding was associated with higher ITR and V1aR gene expression within the Vv/Vl in females but not males, and lower D1R, D2R, and MOR gene expression within several regions that mediates social and reward behavior, including the Dm, Dl, Vs, POA, Vc, and TPp, in both sexes. Our results generate insight into the neural circuitry of teleost pair bonding. More broadly, they show that the neural chemical and anatomical components of butterflyfish pair bonding appear similar to those of mammals, suggesting that the convergent evolution of vertebrate pair bonding has relied on repeatedly co-opting an ancient neural circuitry established in early vertebrates.

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THE HERBIVORE-ALGAE-CORAL INTERACTION AND RESILIENCE OF CORAL REEFS: DIADEMA FACILITATE REEF RECOVERY IN TAIWAN (Abstract ID: 27977 | Poster ID: 669)

The current status (2012–2014) of three key functional groups (corals, herbivores, macroalgae) was examined at three representative coral reefs (Kenting, Lanyu, Lyuado) in Taiwan. Results highlighted strikingly low densities of both herbivorous fishes and herbivorous gastropods at all of the coral reefs, suggesting their loss of function as herbivores. Instead, sea urchin, Diadema spp. now became the key herbivore in the coral reefs, enhancing coral juvenile density, and hence coral resilience in the Taiwanese coral reefs. No correlation was observed between macro-algal covers and coral juvenile densities, suggesting that it would be not macro-algae but smaller algae (turf algae) that negatively affect the coral resilience in the Taiwanese coral reefs. Given the abundance and the impact of Diadema, the Diadema herbivory should be proactively incorporated into management planning of coral reefs in Taiwan. In parallel, revival of functional redundancy in herbivores would be urgently needed in order not to repeat the same tragedy happened in the Caribbean, causing the regional decline of coral reefs by the mass mortality of the then dominant herbivore Diadema.

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CONTRASTING EFFECTS OF BENTHIC ALGAE ON THE CORAL MICROENVIRONMENT (Abstract ID: 29312)

Although a shift from coral to algal dominance has been documented on reefs around the world, the consequence of such transition for the coral microenvironment is poorly understood. We characterised the oxygen microenvironment at interaction zones between the massive coral Porites and different benthic functional groups using microsensors in a flow cell chamber and compared our results with observed interactions in the field in Moorea, French Polynesia. Turf algae, macroalgae and cyanobacteria were successful competitors against Porites. Their interaction zones exhibited a thick diffusive boundary layer (DBL) and large diel oxygen fluctuations, with anoxic or close to anoxic conditions at night. In contrast, Porites competed better against crustose coralline algae and conspecifics. Their interaction zones had a thin DBL and low diel oxygen fluctuations, with less reduced oxygen concentrations at night. Experiments with turf algae showed that the anoxia at the interaction zone during the night was suppressed by antibiotics, demonstrating that it is mediated by microbes. In addition, DBL thickness at the interaction zone decreased with increasing flow and when Porites was upstream of algae. Our data suggest that shifts towards algal dominance, particularly turf algae, macroalgae and cyanobacteria, create microenvironments which favor the accumulation of harmful metabolites and microbes at the interaction zones between corals and algae, potentially causing coral loss. These effects will be mediated by flow speed and direction.

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TEMPORAL DISTRIBUTION ANALYSIS OF PARROTFISH AND SURGEONFISH IN "PARQUE NACIONAL ARRECIFES DE COZUMEL" MEXICO (Abstract ID: 29815 | Poster ID: 228)

Parrotfish and surgeonfish are two of the largest and most conspicuous families of herbivorous fish in the Mesoamerican Barrier Reef System (MBRS). They are a key component in structuring the benthic communities of coral reefs, mainly controlling the algae overgrowth. We evaluated the herbivorous fish assemblage, coral and algae (turf and macroalgae) cover in six fringing coral reef systems in the "Parque Nacional Arrecifes de Cozumel" (PNAC) along 30 m transects at depths of 10 to 15 m, from 2005 to 2011. The relative abundance of fish was variable among reefs and between years: surgeonfish decreased considerably (67%),parrotfish also decreased (50%). The dominant species of herbivorous fish in all reefs of the PNAC were*Acanthurus coeruleus*, *Sparisoma viride* and *Sparisoma aurofrenatum*. The results also showed that through years the cover of coral and algae were inversely proportional in nearly all reefs. There is a positive relationship between the most dominant species of herbivores in the presence of algae. Macroalgae and turf algae increased significantly per reef, while coral cover decreased significantly among years. A proportion of variations per reef in relative abundance of herbivores, coral and algae cover suggest that every reef has a unique biological (coral-benthic algae-herbivorous fish) assemblage. There is evidence that the temporal distribution of parrotfish and surgeonfish among years, affect the coral and benthic algae cover per reef in this period of time.

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'STAYIN' ALIVE': MICROBIOME PATTERNS AND PLAYERS RELATED TO CORAL BLEACHING, RECOVERY AND RESISTANCE. A FIELD STUDY AT KANE'OHE BAY (HAWAI'I) (Abstract ID: 29574)

Coral reefs harbor amazing diversity at the macroscopic, microbial, and molecular scale. Coral holobionts generating this richness associate with rich, functionally dynamic microbiomes. Most biochemical diversity resides in microbes, which may engage in symbioses with metazoans, thereby expanding hosts' adaptation capabilities. Symbiodinium dinoflagellate symbionts are for instance crucial as providing metabolic sustenance for corals. Other close associates such as prokaryotes and fungi are less studied, yet are also believed to be vital partners that underpin ecological competence. Under environmental stress, symbioses become highly sensitive, in particular to elevated temperatures, causing corals to bleach, debilitate and eventually die. In the summer of 2014, ~80% of the reefs in Kaneohe Bay paled, representing one of the most intense bleaching events in Hawai'i since 1940. We used next-generation sequencing to track over 6 months the communities of Symbiodinium, fungi, and bacteria in bleached and resistant coral colonies in the field following this devastating episode. Worldwide, reefs are threatened by a warming climate, but the resilience of some colonies after successive bleaching suggests acclimatization, probably involving shifts in coral-associated microbiomes. Corals ability to alter their symbiotic communities in response to external impacts can be passed to subsequent generations, and this might be key in the process of adaptation to a changing world. These data contribute knowledge on the microbial composition that may infer environmental tolerance in corals.

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CORAL RECORDS OF SEDIMENTATION AND ITS IMPACTS TO CORAL REEFS IN THE EASTERN MALACCA STRAIT (Abstract ID: 29090 | Poster ID: 434)

The Strait of Singapore situated on the southern end of the Malacca Strait is a one of the world's busiest shipping ports that has been experiencing significant dredging and reclamation activities since its independence in 1960s. These activities along with high runoff from a number of rivers have increased sedimentation pressure on coral reefs environment in this narrow strait of importance to reef connectivity in the region. Here, we present coral-based histories of sediment loading (via measurement of coral Ba/Ca), salinity (via coral-derived oxygen isotopic composition of seawater or d18Osw) and a coral metabolism (via carbon isotopic composition or d13C). These records are accompanied with a 1.5 yr-long monthly seawater Ba, d18Osw and salinity in order to understand their relationships on seasonal timescales. Ongoing analysis of rare earth elements may also be presented herein. Our data shows a steady increase in coral Ba/Ca as a proxy for sediment loading since 1960s with episodes of high Ba/Ca, which are in line with reclamation and other environmental events such as river clean up of the main island. Some of these high Ba/Ca episodes also coincide with higher heavy metal Pb reported in our previous work (Lee et al., 2014). Along with these coral-based environmental records, our data reveals a shift towards depleted coral d13O values suggesting a change toward heterotrophy in coral. Overall, our study shows the utility of coral skeletal geochemistry to provide environmental histories such as sedimentation as well as to infer its impacts of coral reefs.

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THERMAL SHOCK INDUCES HOST PROTEOSTASIS DISRUPTION AND ENDOPLASMIC RETICULUM STRESS IN THE MODEL CNIDARIAN*AIPTASIA* (Abstract ID: 29323 | Poster ID: 20)

Coral bleaching has devastating effects on coral survival and reef function, but many of the fundamental cellular effects of thermal stress on cnidarian physiology are unclear. We used label-free liquid chromatography-tandem mass spectrometry to assess the effects of thermal stress on the proteome of the model *Aiptasia* sp. Anemones were allowed to acclimate to elevated temperatures for two weeks or exposed to short-term thermal shock. We identified 2,137 protein clusters in *Aiptasia*, 136 of which were differentially abundant between treatments. There were minimal differences in protein abundances between the control and acclimated high-temperature treatments, indicating that thermal acclimation in symbiotic cnidarians is not primarily regulated at the level of protein expression. Heat shock resulted in significant changes in the abundance of 104 proteins, including those involved in protein folding and synthesis, redox homeostasis, and central metabolism. Highly abundant cytoskeletal and structural proteins showed particularly reduced abundance, demonstrating proteostasis disruption and inhibition of protein synthesis. Heat shock induced multiple mechanisms for stabilizing, degrading and preventing the aggregation of proteins, indicative of endoplasmic reticulum stress. Antioxidant mechanisms and enzymes necessary for redox homeostasis were also upregulated. The effects of thermal shock were most clearly seen at the endoplasmic reticulum, and proteostasis maintenance and protein turnover mechanisms may be essential to cnidarian resistance to thermal shock.

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LATITUDINAL DIVERSITY GRADIENTS OF MULTIPLE TAXA IN REEF COMMUNITIES OF SOUTHERN JAPAN (Abstract ID: 28675)

Latitudinal gradients of species diversity are widely recognized among both terrestrial and marine ecosystems. Understanding species assembly dynamics at the boundaries of climate zones is an important theme of biogeography. In this study, we used visual census data to quantify organisms in reef communities at 19 sites along the Pacific coast of Japan, covering a latitudinal gradient from 24° to 35°N. We measured species richness and abundance of multiple epifaunal taxa, such as fishes, echinoderms, octocorals, mollusks and macroalgae, and analyzed the influence of environmental factors and species traits using generalized linear models. We assigned life history traits to species that are available from literature. Different taxonomic groups showed different dynamics along the latitudinal gradient. Species richness and abundance of fishes increased towards low latitudes. Macroalgae clearly showed the opposite pattern, peaking at high latitudes. Species richness and abundance of other invertebrate groups were highest at intermediate latitudes and lower in coral reef areas. Additionally, in some taxa, communities changed with respect to their trait composition along latitudes. For example, fish communities had a longer mean pelagic larval stage with higher latitudes. Algal communities had more fleshy and large-bodied species at higher latitudes, and more encrusting calcareous algae species in the tropics. These results serve to explain and anticipate changes in community structure and biodiversity as a result of environmental change, such as global warming.

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INVESTING IN CAPITAL – CONVERGING ON A DECISION-SUPPORT APPROACH FOR RESOURCE-POOR AND RESOURCE-RICH CONTEXTS (Abstract ID: 29635)

In increasingly populated tropical coastal regions, achieving the "triple bottom line" of sustainable development requires making complex decisions to balance economic, social and environmental needs and limitations. True sustainability occupies the sweet spot between these three domains. This paper merges concepts from the Capitals Approach and Marine Spatial Planning (MSP) to help deal with the problems of system complexity, mixed objectives and uncertainty, providing tools to concretize a stewardship approach. The challenge is to support decision-making that delivers positive change (growth in one or more capitals) and prevents negative change (decrease in one or more capitals). Nature, society and economy can be viewed as capitals, requiring decisions that reject options that result in loss in any capital, and select those that grow capital(s). In MSP, nature, society and economy define the system to be managed; information is needed on multiple aspects of all three, and a supportive governance context is necessary to facilitate decision-making. The Capitals Approach can also view information and governance as capitals to be invested in, rather than degraded. This simple construct can be implemented at a basic level such as in a scorecard approach, with multiple indicators across all the capitals, and their interactions, in a spatial planning context. All indicators need to be improved, not undermined. At higher levels, complex datasets and models can be integrated to identify solutions that increase capital, to guide decision-making across scales.

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REVIEW OF CORAL CLASSIFICATION STATUS: A CASE STUDY OF KIUNGA MARINE NATIONAL RESERVE, NORTH COAST KENYA (Abstract ID: 29461 | Poster ID: 623)

Coral classification is a dynamic science which requires regular updates on the species name changes, distribution, threats of extinction and the methods used to detect these changes. Use of a single method of classification either morphological or genetic is not

sufficient to confirm the changes. A review of coral classification for the Kiunga Marine National Reserve (KMNR) in north coast Kenya was conducted during January to August last year to ascertain the current status and assess the coverage on phylogenetic literature; IUCN Red List status and reference to threats facing the species which are locally or elsewhere. Results from this study showed that corals from Kiunga Marine National Park were well covered in all aspects of phylogenetic literature with more than three quarters making it possible to adequately group them to their IUCN Red list categories. However, the analysis detected a group of species which had not been assigned into any status on the IUCN Red list classification, representing less than a quarter. With data and information on such omissions, the species could be faced with several threats hence the need to conduct further studies and analysis focusing on acquiring comprehensive data and information for clear establishment of updated status of the taxonomy of corals so as to correctly label them in the groups. This opens up an opportunity to widen the criteria used when assigning the protection and management level of the coral reef ecosystem in Kenya. Key words: morphological classification, genetic classification, IUCN Red list categories,corals

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DIAGNOSING CORAL DISEASE WITH METABOLOMIC MARKERS (Abstract ID: 29430 | Poster ID: 99)

Investigation of coral disease etiology requires multidisciplinary approaches including in-depth molecular analyses. Here, we applied untargeted metabolomics to characterize white syndrome coral disease in the Persian/Arabian Gulf. The Gulf is one of the most extreme environments in which corals occur with high and variable temperatures (23-35°C) and elevated salinity (38-43 PSU).Recent lethality in the branching coral, Acropora, has been caused primarily by a white syndrome disease. We observed tagged Acropora colonies in the Gulf over two years and found that a surprising 63 % of the monitored colonies were visibly infected by white syndrome during summer months. Interestingly, only 5 % of tagged colonies were affected by bleaching during the same period. The syndrome is characterized by fast spreading lesions, which ceased when water temperatures decreased but reappeared on the same colonies in the following summer. To investigate the impact and cause for the disease we apply untargeted ultra-high performance liquid chromatography combined with mass spectrometry from segments of diseased and healthy coral nubbins. Metabolomic profiles show significant differences between infected and healthy parts of the colony. We describe the metabolic pathways impacted by the disease using cross-correlation and comparison with metabolomics databases. Our findings show that untargeted metabolomics is a valuable tool for the investigation of the diseased coral holobiont and improving diagnosis and potential pathogen identification.
https://nyuad.nyu.edu/en/research/faculty-research/the-amin-lab-marine-biogeochemistry.html

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PROVIDING ACCESS TO A DISTRIBUTED NETWORK OF RESOURCES: NOAA'S CORAL REEF INFORMATION SYSTEM (Abstract ID: 28768)

The National Oceanic and Atmospheric Administration's (NOAA's) web-enabled Coral Reef Information System (CoRIS) contains over 10,500 catalog entries for coral related data and publications covering a wide variety of topics including: coral reef mapping, monitoring and assessment; natural and socioeconomic research and modeling; outreach and education; and management and stewardship produced through the NOAA Coral Reef Conservation Program (CRCP) and other coral reef projects. Data and information products are published to a variety of different systems throughout NOAA. Through the use of a variety of web services, CoRIS links these systems together to provide a unified single access point for the public to access the organization's coral ecosystem data and publication holdings. The CoRIS catalog is also exposed through a catalog service endpoint to allow developers to access our catalog holdings without having to go through a predefined user interface. CoRIS provides users with various search options to access materials including spatial, temporal, and topical searches. In addition, project pages are used to highlight, promote, and group materials by topic and/or jurisdiction. Finally, the CoRIS Glossary and Acronym list, defines thousands of terms, acronyms, and abbreviations used in coral reef science and management. With over 1.5 million visitor sessions per year we are reaching a wide audience of educators, managers, and scientists interested in coral reef ecosystems. You can begin your search at http://www.coris.noaa.gov/.

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EVALUATION OF *ACROPORA CERVICORNIS* PRODUCTION TECHNIQUES IN AN OCEAN-BASED NURSERY WITH CONSIDERATION OF CORAL GENOTYPE (Abstract ID: 27927 | Poster ID: 483)

Staghorn coral *Acropora cervicornis* is widely cultured for active reef restoration using a variety of techniques. We conducted a one-year *A. cervicornis* propagation experiment in an offshore nursery in the Florida Keys. Our objective was to examine benthic-attached (block) versus suspended (tree) growout methods and the effect of coral genotype within and between growout methods. In December 2014, 240 5-cm, non-branching apical fragments were collected from established colonies of four genotypes. For the block method, 10 fragments were affixed to each of 12 cinderblocks (3 cinderblocks per genotype). Three tree structures each had 40 fragments from all four genotypes (10 fragments per genotype) randomly assigned to locations across five depths. Temperature was logged hourly and colony condition was observed monthly. Total linear extension of each colony was also measured monthly until November 2015, when only three colonies had survived an extreme bleaching event that began in August. Statistical comparison indicated that colonies grown on blocks bleached sooner but survived longer than those on trees. Comparisons of growout method were made on pre-bleaching data to exclude confounding effects of this stress event. Colonies on trees grew significantly faster than those on blocks but location on trees did not affect growth. Genotype had a significant effect on colony growth which was determined to be consistent across growout methods by *post-hoc* analysis. These findings should be of use for coral nursery managers throughout the Caribbean.

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DEVELOPMENT OF A DEVICE FOR IN SITU COLLECTING, REARING, AND SEEDING CORAL LARVAE (Abstract ID: 28579)

Generally, a shortage of larval supply has been thought a major factor causing delayed coral recovery. In fact, coral eggs and larvae have been found to easily flow out to the outside lagoon among degraded reefs around Okinotorishima, an isolated oceanic island of Japan. Thus, Japan Fisheries Agency developed a device that enables both the in situ seeding and mass culture of coral larvae (hereafter, the device), to promote coral reproduction inside the lagoon. Although this idea had been suggested previously, few studies have addressed the design of such a device at a practical level. We conducted a basic examination for the device's functions using the lattice plate, which enhances the initial survival rate of juvenile corals in Ishigakijima of Okinawa. We also demonstrated the device's durability and effectiveness in Okinotorishima, an isolated oceanic island. We show below the abridged results. a.Appropriate mesh size of the net material of the device: we compared mesh size of the net, an important factor for enhancing survival rate of the enclosed larvae, from 30 to 250 μm. The 30 μm mesh size showed the highest survival rate. b.Quantity of larval collecting and rearing: We assessed the rearing capacity of the device. The maximum number of larvae was 3 million at 4d-old, which they can settle. c.Monitoring the survival of the juvenile corals: We confirmed that the settled corals on lattice plate survived until 18 mo after settlement. d.Demonstration tests in Okinotorishima: We could install the device in Okinotorishima of severe maritime conditions during 7 days.

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MOLECULAR PHYLOGENETIC STUDY OF MUSHROOM CORALS (SCLERACTINIA: FUNGIIDAE) IN THE RYUKYU ARCHIPELAGO, JAPAN (Abstract ID: 28323 | Poster ID: 76)

The family Fungiidae is a member of the reef corals and lives in the tropical and subtropical Indo-Pacific regions. The taxonomy of the family has been recently revised using morpho-molecularly analysis (Gittenberger et al. 2011, Benzoni et al. 2012); the family currently consists of 15 genera and 53 species. The phylogenetic positions of some fungiid species, however, remain unanalyzed. For example, although 36 fungiid species have been reported from Japanese waters (Nishihira and Veron 1995), no phylogenetic

studies have been conducted yet. The present study aims to clarify the phylogenetic relationships of fungiid species inhabiting around Ryukyu archipelago (84 specimens of 12 genera, 28 species), together with published DNA sequences (Gittenberger et al. 2011, Benzoni et al. 2012). Their species identification was performed based on the taxonomic reference (Hoeksema 1989). Material examined includes *Cycloseris hexagonalis* and attached-type of *Fungia fungites* that have never been analyzed molecularly yet. As a result of molecular phylogenetic analyses of two markers (mitochondrial cytochrome oxidase I and the nuclear ribosomal internal transcribed spacers), it is revealed that *C. hexagonalis* formed an independent clade, which is clearly distant from the clades with all other congers as well as other fungiid genera. Moreover, attached and free-living types of *F. fungites* were genetically distinct and placed in two different clades. The systematic positions of these species need to be reviewed with detailed morphological analyses.

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HISTORICAL ANALYSIS OF OCEANOGRAPHIC CONNECTIVITY IN THE PULLEY RIDGE (Abstract ID: 29482)

Pulley Ridge is a mesophotic 60-m-deep reef system located 66-km west of the Dry Tortugas. Far from the coast and surface, it is not affected by coastal pollution and/or bleaching from water temperature fluctuations. Many of the species living at Pulley Ridge are also found in shallower water, and they may be connected. Studying the oceanographic conditions in the region can help determine the extent to which the corals, sponges, and reef fishes living at Pulley Ridge are related to the shallower coral reef ecosystems of the Dry Tortugas and the Florida Keys, and other regions in the west Florida shelf. Here we consider historical surface drifting buoy trajectory data. More than 150 drifters are found to visit the Pulley Ridge area since 1996. A statistics of arrival times to potential settlement sites is constructed. This is compared with that of settlement times of regional species reported in the literature. Potential mean connecting pathways are deduced and the implications of their spatiotemporal variability are discussed.

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QUANTIFYING THE CONSERVATION VALUE OF SEASCAPE CONNECTIVITY: A GLOBAL SYNTHESIS (Abstract ID: 28230)

Connectivity structures populations, communities and ecosystems in the sea. The extent of connectivity is, therefore, predicted to also influence the outcomes of conservation initiatives, such as marine reserves. We reviewed the published evidence of how important seascape connectivity (i.e. landscape connectivity in the sea) is for marine conservation outcomes. In the majority of cases, greater seascape connectivity inside reserves translated into better conservation outcomes (i.e. enhanced productivity and diversity). Research on reserve performance is, however, most often conducted separately from research on connectivity, resulting in few studies (< 5% of all studies of seascape connectivity) that have quantified how connectivity modifies reserve effects on populations, assemblages, or ecosystem functioning in seascapes. Nevertheless, evidence for positive effects of connectivity on reserve performance is geographically widespread, encompassing studies in the Caribbean Sea, Florida Keys and western Pacific Ocean. Given that research rarely connects the effects of connectivity and reserves, our thesis is that stronger linkages between landscape ecology and marine spatial planning are likely to improve conservation outcomes in the sea. The key science challenge is to identify the full range of ecological functions that are modulated by connectivity and the spatial scale over which these functions enhance conservation outcomes.
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ADAPTIVELY MANAGING MARINE PROTECTED AREAS FOR RESILIENCE THROUGH COLLABORATIVE LEARNING AND RESEARCH PARTNERSHIPS (Abstract ID: 27855)

Marine protected areas (MPAs) are an important marine management tool for conserving ecosystems and ecosystem benefits. However, globally, many MPAs are not managed using science-driven approaches, and can be at risk due to local and global threats. By addressing local threats, managers can make ecosystems more resilient to global threats such as climate change. To promote managers ability to recognize and address threats, we developed a pilot program in adaptive management for Kenyan national marine protected areas. Adaptive resource management is an iterative decision making approach where management strategies are continually reviewed and adjusted in response to the best available information. At program inception, we found little management understanding of MPA status or progress toward ecological or social goals. This limited knowledge inhibiting staff ability to determine appropriate management actions. We discuss steps taken to engage MPA staff in adaptive management including establishment of measurable objectives, developing a data collection and evaluation system, and the use of decision-making support tools. We show how the approach transformed thinking at numerous operational levels within an agency – from stakeholders and entry-level MPA staff to the national agency executive committee. Finally, we demonstrate how the stakeholder-manager-researcher partnership resulted in new and creative pathways toward sustainability, including better ongoing planning to achieve both ecological and socio-economic goals.
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CAN SELF-ARMOURING ISLANDS RESIST CLIMATE CHANGE? (Abstract ID: 28045 | Poster ID: 396)

Reef islands (RI) are low lying landforms that are constructed from unconsolidated carbonate sands and gravels that sit atop reef platforms, and have a limited areal extent. Because of the above-mentioned attributes it is often presumed that RI's are sensitive to rising sea levels and/or increased cyclone intensity and frequency. However, there are a number of geomorphic/geochemical processes, including (1) cementation of beach sand to indurated beach rock, and (2) the formation of elevated boulder beaches through the fracturing and transport of beach rock during cyclonic events, that when combined could provide enduring protection (i.e., armouring) against future climate change impacts. Examples of this armouring process are observed on the ~145 RI's that stretch along Australia's NW Pilbara coast, a region that experiences the greatest cyclone intensity/frequency in Australia. Almost all Pilbara RI's are constructed from carbonate sand and have a median island area of ~7 hectares. But unlike Pacific and Indian Ocean RI's that typically have land elevations of < 3 m, Pilbara RI's have elevations that range from 8 to 15 m above mean sea level (MSL). Beachrock is a ubiquitous feature on most islands, but equally common are imbricated boulder beach deposits, which rise to elevations of 4.5 m above MSL level. These boulder beaches are both formed by and provide protection from high-energy cyclonic events, and along with beachrock create a natural seawall that could provide long-term geomorphic stability and increase the resilience of these islands to climate change.

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PREDICTIVE MODELS AND TRADE-OFF ANALYSIS FOR GUIDING COST-EFFECTIVE LAND-BASED MANAGEMENT ACTIONS FOR CONSERVING CORAL REEFS (Abstract ID: 28872)

Land-based source pollutants (LBSP) actively threaten coral reef ecosystems in west Maui and around the world. Managers recognize that changes in land use directly affect the export of sediments and nutrients to reefs, and are targeting management actions towards mitigating LBSP. To be successful and cost-effective in their efforts, managers require appropriate tools to estimate how alternative land use, land cover change, and management practices may drive sediment and nutrient runoff into coastal waters. Additionally, because watersheds often cover multiple landowners, understanding the costs of cooperative versus independent management actions relative to their effectiveness in reducing LBSP is important for guiding cost-effective landscape-scale decision-making. To meet these demands and advance effective and efficient land-based ocean conservation practices, we developed a spatially explicit predictive model that quantifies change in LBSP from dirt road repair management actions (water bars and/or gravelling the roads to divert and/or trap rainfall and sediment) across the landscape in west Maui. We then employed the tool to investigate changes in LBSP arising from alternative spatial configurations of roads repaired across the study domain and among multiple watersheds, and by landowners acting independently or in cooperation. Finally, we integrated our model with a trade-off analysis to identify effective and efficient land-based management strategies that enable managers to maximize the value (and/or minimize the cost) of mitigation efforts while minimizing LBSP.
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DEVELOPING A MULTI-STRESSOR GRADIENT FOR CORAL REEFS (Abstract ID: 29455)

Coral reefs are often found near coastal waters where multiple anthropogenic stressors co-occur at areas of human disturbance. Developing coral reef biocriteria under the U.S. Clean Water Act requires relationships between anthropogenic stressors and coral reef condition to be established. Developing stressor gradients presents challenges including: stressors which co-occur but operate at different or unknown spatial and temporal scales, inconsistent data availability measuring stressor levels, and unknown effects on exposed reef biota. We are developing a generalized stressor model using Puerto Rico as case study location, to represent the cumulative spatial/temporal co-occurrence of multiple anthropogenic stressors. Our approach builds on multi-stressor research in streams and rivers, and focuses on three high-priority stressors identified by coral reef experts: land-based sources of pollution (LBSP), global climate change (GCC) related temperature anomalies, and fishing pressure. Landscape development intensity index, based on land use/land cover data, estimates human impact in watersheds adjacent to coral reefs and is proxy for LBSP. NOAA's retrospective daily thermal anomaly data is used to determine GCC thermal anomalies. Fishing pressure is modeled using gear-specific and fishery landings data. Stressor data was adjusted to a common scale or weighted for relative importance, buffered to account for diminished impact further from source, and compared with coral condition data to provide a conceptual framework relating stressor gradients to effects on coral condition.

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OBSERVING PROCESS IN THE CARBONATE SYSTEM OF PACIFIC REEFS: NATIONAL CORAL REEF MONITORING PROGRAM IN THE PACIFIC (Abstract ID: 29562)

Over the past decade, NOAA's Coral Reef Ecosystem Program has been observing chemical and ecological impacts of changing carbonate systems of Pacific coral reefs at hundreds of sites around 35 islands spread across 45 degrees of latitude and 95 degrees of longitude. I will present an overview of the design of our observation system, with specific reference to the challenges of observing in the face of both temporal and spatial variability. In particular, I will discuss our observations of reef seawater chemistry, including offshore reference sample to provide estimates of Net Ecosystem Calcification (NEC) and Net Ecosystem Production (NEP) at both inter-annual and diurnal time scales. I will further discuss our efforts to develop a time and cost effective measure of net calcification output, and will focus on the results of our Calcification Accretion Units (CAUs). In both cases I will discuss the results of large-scale correlative models to highlight potential environmental and ecological drivers of calcification in these systems, and how these results may inform management and policy.
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COMMUNITY-BASED CORAL AQUACULTURE AND REEF REHABILITATION PROGRAM: THIRTEEN YEARS OF LESSONS LEARNED OF CORAL REEF MANAGEMENT IN PUERTO RICO (Abstract ID: 28417 | Poster ID: 612)

Community-based engagement in coral reef management has become a fundamental tool for supporting institutional activities. It can also foster significant hands-on and behavior-modifying education of community stakeholders through direct participation in conservation projects. However, there is still scarce information regarding lessons learned from such experiences. We discuss the case study of non-governmental organization Sociedad Ambiente Marino (SAM) from Puerto Rico (PR) and its Community-Based Coral Aquaculture and Reef Rehabilitation Program established in 2003. SAM use low-tech coral farming to rehabilitate formerly bombarded coral reefs in PR, in collaboration with the University of Puerto Rico (UPR). This has allowed the academic-NGO integration in multiple marine applied research projects, significantly increasing SAM's technical training for leading conservation oriented research. It also empowered SAM to write their own grants, obtain and administer external funds, and implement multiple projects. In a time of unprecedented socio-economic constriction and declining governance capacity, SAM has become an alternative to provide community-based support to government institutions and the academia conducting conservation-oriented research. This fostered major educational transformation and technical empowerment in SAM to plan and implement priority projects. Outcomes of this include sustained community volunteers engagement, educational and outreach activities, and an increased number of peer-reviewed publications. Lessons learned in the process will be discussed.
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DEVELOPMENT OF ACTIVE RESTORATION METHODOLOGY OF CORAL REEFS IN OKINAWA, JAPAN, USING ASEXUAL REPRODUCTION (Abstract ID: 28233)

Some people are still reluctant for active coral restoration, as they consider that, besides collateral damage to donor reefs, area that can be restored by means of transplantation is very limited to compare large scale degradation of coral reefs. However, as nursery for donor colonies can supply large numbers of transplantable seedling corals and spawning of the out-planted corals brings effective larval dispersion tool for natural recruitment enhancement, the active restoration processes need to be considered. The Coral Reef Preservation and Rehabilitation Project by Okinawa Prefectural Government, Japan, attempts to verify possibility of large-scale reef restoration since 2011. Three hectares of degraded reefs are being restored with more than 100,000 nursery-farmed coral fragments. The restored reefs will become larval dispersion hub after few years. The novel methodology consists of 1) finding of suitable species and location for out-planting, 2) farming of donor corals in nursery, 3) genomic DNA analysis of donor colonies, 4) farming of seedling fragments in nursery, 5) out-planting design for a single species without clonal colony, 6) combination of various species in wide area, and 7) long term monitoring.

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EVIDENCE FOR CLIMATE-DRIVEN SYNCHRONY OF MARINE AND TERRESTRIAL ECOSYSTEMS IN NORTHWEST AUSTRALIA (Abstract ID: 28477)

The effects of climate change are difficult to predict for many marine species because little is known of their response to climate variations in the past. However, long-term chronologies of growth, a variable that integrates multiple physical and biological factors, are now available for several marine taxa. These allow us to search for climate-driven synchrony in growth across multiple taxa and ecosystems, identifying the key processes driving biological responses at large spatial scales. We hypothesized that in northwest Australia, a region predicted to be strongly influenced by climate change, the El Niño Southern Oscillation (ENSO) phenomenon would influence the growth patterns of organisms across ecosystems. To test this idea, we analysed the growth chronologies of two marine fish *Lutjanus argentimaculatus* and *Lethrinus nebulosus*, the coral *Porites* spp. and the tree *Callitris columellaris*. Principal components analysis and linear model selection showed evidence of ENSO-driven synchrony in growth among all four taxa at inter-annual time scales, the first such result for the Southern Hemisphere. Rainfall, sea surface temperature and sea surface salinity, which are linked to the ENSO system, influenced the annual growth of fishes, trees and corals. All four taxa had negative relationships with ENSO, where positive growth patterns occurred during strong La Niña years. This finding implies that future changes in the strength and frequency of ENSO events are likely to have major consequences for both marine and terrestrial taxa.

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CRUSTOSE CORALLINE ALGAE, DOLOMITE, AND THE HISTORY OF MG/CA WITHIN THE CENOZOIC OCEAN (Abstract ID: 29849)

It has been recognized by several scientists over the past 30 years that dolomite precipitation, or lack of it, drives the Mg/Ca of sea water on time scales of millions of years.

The problem has been that no one had been able to put their finger on a mechanism for the deposition of abundant dolomite in marine and in particular coral reef ecosystems. With the discovery that crustose coralline algae (CCA) is the source of dolomite, we now have a specific sedimentary depositional environment we can call on for its origins. The CCA dominated algal rims and flats, most pronounced on mature and senile reefs, have the highest concentrations of dolomite, and are largely located in the intertidal zone. What we observe is that CCA abundance becomes more pronounced if the reef flat spends longer within that intertidal zone, hence sea level stability is key to concentrating significant thicknesses of the dolomite rich CCA. I will present a model that illustrates how sea level instability has lead to the decline in the abundance of this stable shallow water environment ever since Antarctica was glaciated 33.9 million years ago. This has lead to a corresponding decline in dolomite deposition and an increase in the Mg/Ca of sea water through the late Cenozoic.

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SPATIAL AND TEMPORAL PATTERNS OF RECRUITMENT AND REPRODUCTION, AND STOCK-RECRUITMENT RELATIONSHIP OF CRUSTOSE CORALLINE ALGAE ON HERON ISLAND- GBR (Abstract ID: 28042)

Crustose coralline algae (CCA) are key organisms for coral reef ecosystems as they play important roles in reef building and reef resilience. While the number of studies looking at the impacts of anthropogenic activities on CCA has recently increased, very little is still known about their basic biological and ecological processes. This study aims to understand the spatial and temporal patterns of reproduction, recruitment, and the relationship between early stages and adult abundance of CCA around Heron Island, southern Great Barrier Reef, Australia. Three reef habitats were studied across four climatic seasons. CCA recruitment patterns were assessed using settlement plates and surveys were carried out to study the community of CCA adults. To determine the nature of the relationship between reproduction and recruitment, the reproductive structures of *Porolithon. c. f. onkodes* sp. were analysed at each habitat and season. The recruitment of CCA in Heron island reef varied significantly throughout the year and among reef habitats. Community structure of both the recruits and adults varied among seasons and habitats. Further, a positive relationship between reproductive output and recruitment, and adult stock and recruitment abundance was found, suggesting that CCA populations are, predominantly, "closed" populations. Overall, this information is fundamental for a better understanding of the patterns and causes of algal distributions in reefs, and the possible impacts of global environmental change on this important group of reef builders.

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ACTIONS TO ENHANCE ENFORCEMENT IN THE U.S. VIRGIN ISLANDS THROUGH CAPACITY BUILDING TOWARD CORAL REEF ECOSYSTEM PROTECTION (Abstract ID: 28160)

The USVI priority setting and capacity assessment processes identified the need for improved enforcement as a key priority in order to improve the condition and sustainability of coral reef ecosystem resources. Historically, people living and working in USVI have identified the need for improved enforcement as a Territorial priority as reflected in the USVI economic assessment and in the 2005 "United Stated Virgin Islands Marine Resources and Fisheries Strategic and Comprehensive Conservation Plan" created by the Department of Planning and Natural Resources (DPNR) Division of Fish and Wildlife in part by interviewing commercial and recreational fishers and researchers in USVI. All groups suggested the need for additional officers, increased patrols, and increased site inspections supported through increased funding. The 2012 USVI Capacity Assessment made similar recommendations. NOAA's Coral Reef Conservation Program provided multi-year funds through FY13 to build capacity through officer training, a policy gap analysis and targeted solutions, and the analysis of enforcement data to identify focal areas for a long-term training plan. DPNR is now also working toward the creation and implementation of a strategic plan for enforcement to enhance consistency of enforcement procedures and increase capacity for protection of coral reef ecosystems in the USVI.

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CHARACTERIZATION OF METABOLITES IN CORALS UNDER CONDITIONS OF HIGH SALINITY (Abstract ID: 28615 | Poster ID: 105)

Corals are frequently exposed to changes in salinity. Previously, it was thought that they could not respond to these changes; however, recent literature suggests them to be osmoconformers, i.e. able to maintain an internal environment that is isosmotic to their external environment. To further understand the effects of increased salinity on corals, we conducted a long-term *in situ* experiment with *Fungia granulosa* exposed to highly increased salinity levels. Contrary to expectation, coral colonies appeared visually healthy and photosynthesis efficiency was unaffected indicating unimpaired coral host and algal symbiont functioning. In comparison, the associated microbiome displayed drastic changes that could be associated with putative changes in metabolite production associated with salinity tolerance. We are currently applying Gas Chromatography Mass Spectrometry (GC/MS) to quantify the concentration of metabolites and subsequent identification by comparison to a reference compound library. We expect to find different metabolite concentrations in the coral holobiont under different salinity levels, and we will discuss possible osmoregulatory functions of these metabolites.

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THE EFFECT OF WAVE EXPOSURE AND COMPETITION FOR SPACE ON THE COMMUNITY COMPOSITION OF CORAL REEFS (Abstract ID: 28936)

The effect of wave energy on the survivorship of corals is highly dependent on the coral growth form. Corals with higher skeletal density and lower resistance against water motion are less likely to be affected by wave energy. Here we use high resolution wave modelling to assess the effect of wave exposure on the relative abundance of corals grouped in three growth forms (massive, branching and tabular) around Heron Island Reef (Eastern Australia). We then incorporate the empirical relationships observed in an existing coral reef ecosystem model to be able to explore the effect of future disturbance scenarios at different levels of wave exposure. Our results suggest that 52% of the variability in coral community composition can be explained using a combination of 4 wave exposure metrics and the slope of the reef. We also identify that at low levels of wave exposure dominant populations are highly resistant to competitive displacement due to the low natural mortality in these conditions. These results suggests that although wave exposure can be used to predict the relative abundance of different growth forms, at least at low levels of wave exposure, ecological interactions and unusual recruitment events may be stronger drivers of community composition.

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CONSUMER'S RESPONSIBLE SEAFOOD CONSUMPTION IS VITAL FOR CORAL REEF HEALTH (Abstract ID: 28155 | Poster ID: 262)

The Caribbean Fishery Management Council Outreach and Education initiative is targeting seafood consumers: fishers, fishmongers, fish markets restaurant owners and general public, to promote public understanding of coral reef dynamics, and thus understand the importance and significance of management measures applied to the fisheries. The main goal of this initiative is to establish the basis for a fisheries literacy among the consumer public to support a sustainable reef fishery, beginning with responsible fishers and a consumer's chain that will purchase species not prohibited and with healthy populations. Coral reefs are complex ecosystems in which the physical structure, the species dynamics of corals and other species, physico-chemical and biotic processes and connections among them, including human activities define the health of the ecosystem. Fish and invertebrate species that form the fisheries in the Caribbean Region are all part of this complex ecosystem, and understanding the dynamics of their populations by the consumers is essential. The management measures that need to be applied to these species (closed seasons and/or closed areas to protect reproduction aggregations or areas where the juvenile grow) have socioeconomic impact on their communities. This information very rarely is delivered to the consumers in understandable format and language. Through outreach and education strategies consumers understand why they should not consume these species during their closed seasons, and the need for these management measures, that on the long term, guarantee that the populations of these species will be healthy and that the fisheries will be sustainable.
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SPATIAL PATTERNS OF SYMBIONTS AND CORALS ARISING FROM PROPAGULE REDIRECTION (Abstract ID: 27987)

The density of organisms typically varies among habitat patches (e.g., coral colonies), often due to inherent properties of a patch (e.g. the species of coral that comprises the patch or the density of other symbionts that occupy the patch). However, the density of coral symbionts, such as fish, also can be influenced by the density and proximity of adjacent coral colonies. Here, we summarize past work on "propagule redirection" (or settlement shadows: i.e., depletion of larval settlers by adjacent habitat) and explore its long-term consequences on spatial patterns in fishes (or other coral symbionts). Using spatially explicit simulations and analytic models, we determine the situations in which variation in the density of symbionts can be achieved even when patches are identical in their inherent quality. Heterogeneous patterns of settlement result from propagule redirection when corals patches are distributed non-uniformly in space. This heterogeneity in settlement persists in the long-term (e.g., at the adult stage) when there is a low supply of settlers, weak post-settlement density-dependent survival, and longer times between settlement events. Variation in settlement arising from the spatial patterning of habitat can therefore be an important process shaping long-term spatial patterns of organisms occupying patchy habitats. Furthermore, because the density of symbionts can affect coral growth and survival, propagule redirection may be responsible for pattern formation in corals, as well as in the organisms that occupy these corals.

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REEFOLUTION – A NEW CORAL REEF DEVELOPMENT PROGRAM IN KENYA (Abstract ID: 29335)

A reef development program named REEFolution was recently launched in Southeast Kenya, aiming at improving coral reef environments in order to enhance fish stocks, increase possibilities for dive tourism and conserve nature. Pilot activities started in September 2015 with the positioning of three types of coral nurseries in the Wasini Channel, a shallow, dynamic coastal area with a high tidal amplitude, moderate coral cover and a relatively high turbidity. Nursery types tested were 1) rope nurseries positioned on the seafloor (variable distance to the sea surface); 2) rope nurseries on floating frames (fixed distance to the sea surface) and 3) tree-type nurseries. Four species of coral were cultured on each nursery type: three scleractinian corals (*Porites cylindrica*, *Acropora muricata*, *Pocillopora meandrina*) and one fire coral (*Millepora* sp). Whereas *Acropora*, *Pocillopora*and *Millepora* performed well, with high survival rates and good growth during the first three months, culture of *Porites* was less successful. The three nursery types performed similarly; the tree-type nurseries were least sensitive to fouling and were the most convenient option regarding costs for construction and maintenance. Current activities of the program include upscaling of the nurseries, outplacement of cultured corals on damaged areas of natural reefs (reef restoration) and the installation of artificial structures for outplacement of cultured corals (reef building). Future plans include the establishment of an offshore, floating reef that may act as a refuge for corals under the threats of climate change.

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REORGANIZATION OF THE CORAL MICROBIOME ACROSS LATITUDINAL GRADIENTS OF THERMAL HISTORY IN THE RED SEA (Abstract ID: 29538)

Corals in the Red Sea where seasonal sea surface temperatures can be extreme, provide unique capacity to gauge the physiological and molecular adjustments required for reef resistance to climate change. Whilst the coral host can physiologically adapt to persist and thrive in more marginal environments, the role of associated microbiome and Symbiodinium spp. reorganization ("holobiont adaptation") remains unresolved. We therefore examined how symbiont identity (ITS2, psbA) and the bacterial community structure (16S meta-genomic next generation sequencing) differs along thermal gradient of the Red Sea. Corals were sampled from six key coral species persisting across five sites across Red Sea (29˚ to 20˚ N) that experience different thermal regimes. Symbiodinium spp. ITS2 identity associated with each coral species generally remained highly conserved throughout the sites sampled; however, psbA diverged with latitude, particularly within Porites sp. suggesting population-level differences. In contrast, and consistent with recent studies, we report for the first time in the Red Sea, the variability in microbial communities within and between species across sites. Corals from two sites (Hurghada and Jeddah) were exposed to a thermal stress experiment which demonstrated that corals were more heat resistant at Hurghada (annual SST mean is 3.3 ˚C less than Jeddah); however Symbiodinium clade types (ITS2) were identical at both sites. The functional role of the microbiome in the thermal tolerance of the holobiont across different thermal regimes is currently being explored.

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THE FISHMARK TOOL FOR BENCHMARKING FISHERIES MANAGEMENT IN MUNICIPAL WATERS (Abstract ID: 29439)

Fisheries laws in the Philippines provide an enabling environment for local fisheries management programs in municipal waters. These programs generally comprise of adoption of a fisheries management plan, enforcement, institutional development and partnership, legislation and regulation, and monitoring and evaluation. After over two decades of local fisheries governance and considerable efforts done in coastal resources management, fisheries management remains a lesser priority of local governments. One of the prevailing issues is the limited capacity to assess the effectiveness of their programs on fisheries management. The Fisheries Management Assessment and Rating Toolkit (FishMARK)aims to objectively monitor and evaluate programs relative to fisheries management with focus on capture and marine-related fisheries. It serves as a tool to gather critical lessons on adaptive management and sustainability. Nested in five governance areas, the FishMARK consists of 27 indicators and 108 verifiable sub-indicators. The FishMARK is a means to improve management of fisheries by LGUs by reviewing actions (inputs) and assessing results (outcomes). A FISHMARK evaluation was conducted in 12 focal sites across the Philippines. Preliminary results show that more than half of the sites fall under very similar conditions either at Pre-level or Level 1. Ultimately, the results would show that a standardized tool is critical. Lessons were identified to help redirect efforts toward adaptive management.

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IMPACT OF SNORKELERS ON SHALLOW CORAL REEF COMMUNITIES IN PALAU (Abstract ID: 29036)

The Republic of Palau has always been a popular destination for tourists, especially those who seek to snorkel and/or dive Palau's World Heritage reefs. Over the past couple of years, concerns on the state of marine ecosystems have risen due to the rapid increase of visitors at snorkeling sites. In 2008, Palau had a total of 83,180 visitors. In 2015, that number had almost doubled to over 161,000 visitors. This study investigated the impacts of snorkelers on the shallow coral reef communities, their behaviors in the water, and the tour guide practices. Surveys on coral fragmentation, benthic cover, fish density, snorkelers and tour guide behaviors were conducted in July 2015 and January 2016 at 5 popular snorkeling sites and 5 non-popular sites within the World Heritage Site. Results showed a higher coral fragmentation and percentage cover of rubble at most of the popular sites than at the non-popular sites. Most of the visitors came from neighboring Asian countries such as China, Japan, Taiwan and Korea. A majority of these groups that visited the studied sites lacked confident swimming abilities and relied heavily on floatation devices. Observations showed lack of proper in-water guidance and supervision of snorkelers. Any correlation between reef assessment and snorkelers and/or tour guides' behaviors will also be explored and presented. Findings will be adapted into management recommendations and communicated to government agencies to improve the present conservation management practices.

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FILL AN OLD NICHE OR FIND A NEW ONE? COMPARING HABITAT USE FOR INVASIVE REEF FISHES IN NATIVE AND INVADED CORAL REEF HABITATS WITH SPECIES DISTRIBUTION MODELS (Abstract ID: 29988)

Two snappers (Lutjanus kasmira and L. fulvus) and one grouper (Cephalopholis argus) were introduced to the Main Hawaiian Islands in the 1950s to boost local coral reef fisheries. These introduced species have native home ranges in other archipelagos in the Western Central Pacific Ocean. Their success as prominent fisheries have been lack-

luster for various reasons despite successful establishment in the Hawaiian Archipelago. The establishing success of an introduced species in a new area is related to how well it interacts with its new environment. Habitat use is a common way to understand the niche partitioning of introduced organisms in new environments. Herein, we employ current species distribution modelling approaches to link pertinent benthic habitat and environmental covariates with the distributions of these three species from standard reef fish diver surveys in the Main Hawaiian Islands, Mariana Archipelago, and American Samoa. Subsequently, for each species the models were cross-evaluated among regions to quantify the extent to which benthic habitat and environmental covariates could predict species density by juvenile and adult life stages in the different regions. This type of work provides insight into the niche structure of these species in their native and invaded habitats, as well as the generality of habitat-based species distribution modelling on broad geographic scales.

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USING SCIENCE TO INFORM TRADITIONAL MARINE RESOURCE MANAGEMENT (SASI) IN THE BIRD'S HEAD SEASCAPE MPA NETWORK, RAJA AMPAT, INDONESIA (Abstract ID: 28300 | Poster ID: 613)

Sasi is a traditional marine resource management system in the Raja Ampat Archipelago, Indonesia that has been in place for multiple generations. Sasi is managed by a clan (within an Indonesian social clan system) and/or by a religious governing body (e.g. Church), typically consisting of periodic closures for key species. Bridging traditional wisdom and modern fisheries science, we conducted a study to inform best sasi practices to optimize catch of key fisheries species. Specifically, we conducted a study within Kawe MPA to investigate changes in catch of key fisheries species across different periodic closures. Length and weight was recorded from sasi target species caught by local fishers, including sea cucumbers (Holothuria), lobster (Panulirus), and top-shell (Trochus) during the sasi opening event in 2009 (following a one year closure) and again in 2012 (following a three year closure) .As expected, results showed that catch amount, size, and length from a sasi location that was closed for three years was significantly higher than catch following a one year closure. However, the three year closure restricted access to key fisheries species for a much longer duration. Using this information, we developed recommendations for individual sasi species based on their life-history to maximize catch which fell between the one and three year closures. This study will provide recommendations for management guidelines across the Bird's Head Seascape MPA network to optimize catch of sasi species supporting the continuation of sustainable fisheries practices.

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IMPACTS & DYNAMICS OF AN OUTBREAK SPECIES OF CORAL ON A REMOTE ATOLL BEFORE AND AFTER A SUPER-TYPHOON (Abstract ID: 28030)

Despite relatively low human population sizes in Ulithi Atoll, Micronesia, concern is mounting over declining coral reef health. Upon invitation, we began conducting annual ecological surveys there in 2012. We documented an "outbreak" coral - an undescribed species of Montipora. Its presence is strongly correlated with human activities, peaking in abundance at boat landings, heavily fished areas, and moderately exposed sites. This coral appears to be causing declines in reef function due to its ability to quickly overgrow other corals, limiting coral diversity, reducing structural complexity, and depressing fish diversity and abundance. Its presence and abundance on reefs was a major driver in site clustering based on benthic structure, and dendrograms of fish diversity showed remarkably similar patterns, indicative of ecological relationships between corals and fish communities. Clustering of reef sites remained stable for 3 years; however, in 2015, Typhoon Maysak hit Ulithi Atoll directly, causing severe damage. We surveyed reefs on and adjacent to the Atoll 2 months post-typhoon and found that while coral community structure was relatively stable among sites, the outbreak Montipora sp. was strongly impacted, with live cover reduced to fine rubble due to wave action and heavy scouring at many sites. Our 2016 surveys will help reveal whether the storm and the reef management actions of the islanders will affect the dynamics of this outbreak, allowing formerly Montipora-dominated reefs to regain species diversity, or whether the disturbance will facilitate its spread.
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GULF OF MANNAR MARINE NATIONAL PARK: MEASURES NEEDED FOR STRENGTHENING EFFECTIVE CONSERVATION (Abstract ID: 28626 | Poster ID: 674)

The Gulf of Mannar (GoM) biosphere reserve (10500 sq. km., with 21 fringing reefs) is the second reef region to be afforded total protection by the Government of India since 1986. In conjunction with the declaration of all reef building corals as fully protected in 2001, this was expected to improve the health of the reefs in GoM. This has not happened to the expected extent and this paper identifies the reasons why. By comparing the conservation initiatives of the GoM with those of the Great Barrier Reef (GBR), this paper discusses what measures could add strength to the conservation of reefs of the third world and how sustainable management of reef resources could be built into the conservation initiatives. Some such measures needed are scientific studies such as coral reproduction, recruitment rate, community dynamics and post-bleaching structure of the ecosystem that could help in identifying the priority areas for attention and improve the health, function and resilience of the reef ecosystem. This also needs to be supplemented with policies on rational and sustainable use of renewable organic reef resources such as commercial and recreational fisheries, pharmaceutical and bio-active compounds. The value of this discussion lies in its applicability to reefs beyond the GoM, to those in several other regions where scientific approaches are not as well developed as in the GBR case.

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MORPHOLOGICAL VARIATION IN THE COLONIES OF THE HARD CORAL ACROPORA HYACINTHUS IN SHELTERED AND EXPOSED CONDITIONS (Abstract ID: 29420 | Poster ID: 42)

Aspects of colony morphology and population genetic structure were measured for several colonies of the hard coral Acropora hyacinthus in exposed and protected reefs in the Philippines to investigate the effect of wave exposure on the structure of colonies. Measurements were made on underwater photographs of live colonies to limit time spent in the field. A size and color reference card was included in each photograph. No significant differences in colony morphology were found between colonies in exposed and sheltered areas for colony size, branch density and branch thickness; though there was a significant difference in the diameter of the axial corallites (those in the exposed colonies were slightly smaller). There was a significant difference in the depth where these colonies were found, with those in the exposed area being found deeper and on the reef slope while those in the sheltered area found shallower and on the reef flat.

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ENVIRONMENTAL EFFECTS ON SEXUAL REPRODUCTION OF REEF BUILDING CORALS FROM HAWAII. (Abstract ID: 29978)

Using field observations and laboratory analyses we explored the reproductive biology of two of the most broadly distributed and important reef builders in the main Hawaiian Islands, *Montipora capitata* and *Porites compressa*. Specifically, this study examined (1) the relationship between environment, size, morphology and reproductive capacity in *Montipora capitata* (2) the role of parental effects in dictating the phenotypic range of traits in coral offspring and (3) how thermal stress (bleaching) affects the reproductive biology of both *M. capitata* and *P. compressa* located in areas with different sedimentation regimes. Our results indicate that spawning in M. capitata varies among years, months and lunar days, and that the proportion of colonies spawning and synchrony of spawning do not reflect coral colony morphology or colony size. Furthermore, we found large biochemical differences between adults and eggs, with the latter containing higher concentration of lipids, ubiquitinated proteins and antioxidants. Despite the broad phenotypic plasticity displayed by adults, parental investment in the context of provisioning of energy reserves and antioxidant defense was the same in eggs from the different sites. Current analyses are focused on comparing reproductive characteristics in colonies (from both species) exposed to different sedimentation regimes and that were affected during the 2014 bleaching event.

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CUES FROM SPACE WAR OF MARINE SPONGES AND THE RELATIONSHIP WITH HUMAN TUMOR CELL PROLIFERATION INHIBITORY ACTIVITY (Abstract ID: 29377 | Poster ID: 101)

Twenty five species of marine sponges were selectively sampled from coral reefs of Palk Bay and Gulf of Mannar, India. The selection was based on sponges growing in sheltered environment, least diverse area (<3-8 individuals/$M^2$), and absence of conspicuous surface macrofoulers. Extracts of selected sponges were subjected to cytotoxicity (100µg $ml^{-1}$) with brine shrimp (*Artemia salina*) and anticancer activity (25µg $ml^{-1}$) against human breast, stomach (AGS), lung, central nervous system (CNS) and colon tumor cell lines. About 88% of the sponge extracts tested showed cytotoxicity to*Artemia salina* and the mortality varied between 16 and 100%. Nine species showed more than 90% mortality. With regard to anticancer activity, extracts of 56% of sponges

were active. Among the various cell lines screened against sponge metabolites, colon cancer cell line was more susceptible (52%) followed by breast (20%), lung (32%), CNS (32%), and AGS (28%). The breast cell line was least susceptible. The extracts of *Axinella tenuidigitata*, *Axinella carteri*, *Clathria procera*, *Petrosia nigricans* and*Oceanapia fistulosa*, were active against almost all cancer cell lines tested. The highest cytotoxicity among the cell lines varied between 43.67 ± 2.42 and 80.03 ± 8.89%. Significant correlation was found between cytotoxic activity and the observed surface fouling and reduction in sponge habitat diversity.

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MICROFRAGMENTING FOR THE SUCCESSFUL PROPAGATION AND RESTORATION OF SLOW GROWING BOULDER CORALS (Abstract ID: 28710)

Slow growing, massive stony corals have often been overlooked in reef-restoration activities, despite their significant contribution to reef framework. Techniques to effectively propagate and successfully outplant these species have proven challenging, however, advancement in methodology may increase rates of success. In 2013, Orbicella faveolata and Montastrea cavernosa fragments were outplanted on reefs within the lower Florida Keys, to determine whether "microfragmenting" corals increased the rate of survival and substrate coverage (a proxy for growth) after outplanting. Microfragmenting was defined as a method of cutting parent colonies into several 1 x 1 cm fragments (i.e., microfragments).Arrays of eight microfragments, each from the same parent colony and totaling about 50 cm2, were planted near one large fragment of similar size. Eight replicate pairs were randomly planted within the study site, which was approximately 100m2. Fragments were monitored for substrate coverage and survival over 31 months, spanning two bleaching events. Initial predation occurred to varying degrees on microfragments, but was absent in large fragments. Survival and growth did not differ overall between large fragments and microfragment arrays. However, excluding plots with >40% predation showed that O.faveolata microfragment arrays covered 14 times more substrate than the traditionally used large fragment. Results from this study suggest that if predation events are reduced, massive corals can be successfully grown and outplanted for restoration purposes.

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DIFFERENTIAL MODIFICATIONS OF SEAWATER CARBONATE CHEMISTRY BY MAJOR CORAL REEF BENTHIC COMMUNITIES (Abstract ID: 28171)

Ocean acidification (OA) may threaten coral reefs through reduction of calcification and increased calcium carbonate bioerosion and dissolution. In addition to anthropogenic OA, reef seawater carbonate chemistry is strongly influenced by benthic net metabolism. Therefore, predicting future reef seawater carbonate chemistry requires an understanding of how benthic communities modify their chemical environment and the potential metabolic responses of these communities to future environmental change. The relationship between five benthic reef communities (sand, crustose coralline algae, coral, fleshy algae, and mixed community) and seawater carbonate chemistry was studied in flow-through mesocosm experiments during two seasons under ambient and acidified conditions. Graphic analysis of total alkalinity (TA) and dissolved inorganic carbon (DIC) vectors was used to assess the relative balance between net community calcification and net community organic production, and whether TA-DIC relationships can be used as a tool to characterize benthic reef metabolism and composition. Fleshy algae, which had the lowest TA-DIC slopes, elevated seawater pH the most during the day while calcifying communities had the highest TA-DIC slopes but very small influence on seawater pH. The mixed community fell between fleshy algae and calcifying communities with intermediate slopes and modest elevation of daytime seawater pH. Significantly higher nighttime dissolution rates resulted in increased TA-DIC slopes and partially buffered against nighttime acidification owing to net respiration.

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PRESENCE AND IMPACTS OF LAND-BASED SOURCES OF POLLUTION IN THE ST. THOMAS EAST END RESERVES, ST. THOMAS, USVI (Abstract ID: 29586)

The St. Thomas East End Reserves, or STEER is a collection of Marine Reserves and Wildlife Sanctuaries located on the southeastern end of the island of St. Thomas, U.S. Virgin Islands. NOAA's National Centers for Coastal Ocean Science conducted a project to develop an integrated assessment of chemical contaminants, bioeffects and a biological survey of the STEER. The information generated from this assessment is being used to establish a baseline of conditions, so that managers can understand not only the status, but also specific challenges that exist to improve the ecological functioning of the STEER. One hundred and eighty-five chemical contaminants, including a number of organic (e.g., hydrocarbons and pesticides) and inorganic (e.g., metals) compounds were quantified in the STEER. Nutrients and sedimentation were also monitored as part of the project. Higher levels of chemical contaminants were found in Mangrove Lagoon and Benner Bay in the western portion of the study area. Copper at one site in Benner Bay was above a NOAA guideline (ERM) indicating that effects on benthic organisms were likely. The concentration of tributyltin (TBT) in sediment cores was nearly an order of magnitude higher than any found in NOAA's National Status and Trends (NS&T) Program data base. Results of multiple bioassays indicated significant sediment toxicity in Mangrove Lagoon and Benner Bay. The benthic infaunal communities in Mangrove Lagoon and Benner Bay were also severely diminished. Nutrients and sedimentation were elevated in the STEER as well; some concentrations were above proposed thresholds, which could indicate impacts to the reefs in the STEER

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MARINE PROTECTED AREAS AND POVERTY ALLEVIATION: SHORT TERM INSIGHTS FROM PAPUA, INDONESIA (Abstract ID: 29657)

Marine protected areas (MPAs) are an integral component of local, national, and international strategies for biodiversity conservation, but their impacts on human well-being remain contested. Advocates tout MPAs as win-win strategies for conservation and poverty alleviation, while opponents argue that MPAs place the welfare of fish above the well-being of impoverished fishing communities. To inform this debate, we are monitoring the social impacts of six MPAs in the Bird's Head Seascape (BHS). Using a quasi-experimental design, we examine social well-being across five social domains: economic well-being, health, political empowerment, education, and culture. Preliminary impact data from six MPAs and matched controls provides insights into the short-term impacts of MPA establishment on household well-being. We find that the social impacts of MPAs are far from uniform, with the magnitude and direction of impacts varying within and among social groups, across social domains, and between sites, resulting in complex arrays of impacts. In addition to providing insights for site-level adaptive management, the variable social impacts of MPA establishment in the BHS highlights the need for a more nuanced approach to evaluating the social impacts of conservation interventions as the foundation for analyzing protected area –poverty linkages.

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EFFECT OF BALANCED AND IMBALANCED NUTRIENT ENRICHMENT ON THE BLEACHING RESPONSE OF TWO CARIBBEAN CORALS DURING HEAT STRESS (Abstract ID: 29993)

Interacting global and local stressors usually act together in driving the decline of coral reefs, with local impacts such as declining water quality often exacerbating global impacts such as coral bleaching, and vice versa. Recently, it has been suggested that poor water quality can decrease coral thermotolerance, either due to proliferation of the coral's algal symbionts under high nutrients and/or to exposure to imbalanced nutrient supply. We investigated the effect of balanced and imbalanced nutrient addition on the abundance of different *Symbiodinium* hosted by the Caribbean corals*Siderastrea siderea* and *Montastraea cavernosa* and their subsequent response to heat stress. Replicate cores (N=60, from 6 colonies of each species) were exposed to elevated nitrogen (N), nitrogen+phosphorus (NP), nitrogen+phosphorous+feeding (NPF), or iron (Fe), and compared to controls over a 180-day period. Thermotolerance was then measured by exposing corals to 32°C for 2 weeks. Throughout the experiment we used quantitative PCR to identify and quantify different symbionts, and chlorophyll fluorometry to assess their photochemical efficiency (Fv/Fm). This study allowed us to test the degree to which improving water quality might enhance future coral reef resilience to continued global warming.

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MULTIPLE PREDATOR EFFECTS ON JUVENILE PREY MORTALITY (Abstract ID: 28594)

Loss of marine top-predators often leads to mesopredator release. Understanding the net effect that mesopredator release may have on low trophic-level fish is a key issue, but can be challenging to predict and measure in situ. Each mesopredator can impact prey

differentially and generally their combined effects cannot be predicted from their independent contributions. Using small mesopredator fishes with either active (*Pseudochromis fuscus* (F)) or ambush hunting mode (*Cephalopholis boenak* (B) and *Epinephelus maculatus* (M)), we conducted a mesocosm experiment to examine their predation rate on six damselfish juveniles (*Pomacentrus* spp). Treatments included each predator on its own (F, B, M) and all possible paired interactions (FF, BB, MM, FB, FM, BM). Prey mortality from predator pairs with different hunting mode either matched (FB) or exceeded (FM) the mortality expected from their individual effects. Interestingly, although pairs of active predators (FF) caused the expected mortality, the combination of ambush predators did generate risk-enhancing effects, but only within intraspecific pairs (BB, MM). For the interspecific combination of ambush predators (BM), prey mortality was lower than predicted (risk-reducing effect). Our study suggests multiple predator effects may be influenced by the hunting mode of predators, but also by the specific taxon of the species interacting. Further, it highlights the complexity of intraguild behavioural interactions and their importance for accurately predicting the consequences of mesopredator release.

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THRIVING IN THE FACE OF NATURAL EXTREMES: WHAT HAVE WE LEARNED AT OFU ISLAND, AMERICAN SAMOA, ABOUT THE FUTURE ADAPTABILITY OF CORALS? (Abstract ID: 28221)

Healthy, growing corals in the back reef lagoons of Ofu Island experience large periodic swings in temperature, pH, oxygen, and other environmental factors that conventional wisdom suggests should limit their survival. An eight-year research program has used genomics, reciprocal transplants, common gardens and standardized stress tests to show that that these corals adapt and acclimate to environmental extremes across short temporal and spatial scales. Transcriptome and genome-wide variants help pinpoint the physiological traits most central to adaptation and acclimation, and highlight the genetic machinery associated with effective adaptation. The genetic architecture of adaptation appears to involve hundreds of genes, yet each individual coral also shows the ability to adjust its physiological tolerances through rapid acclimation. In addition, symbiont type varies with location and bleaching history. A general evolutionary model suggests that a high variability in fitness traits in the face of environmental variation is expected when environmental change occurs over spatial scales that are shorter than dispersal distances. This short scale of variation is common for reef species that live across fore and back reef environments. As a result, genetic variation for environmental resilience may be a common feature of large reef populations. Using this variation to enhance future reef survival might be advanced by protection of adaptation hotspots, restoration using the most resilient colonies, and maintenance of large populations with high variability.

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IMPROVING SCIENTIFIC INPUT INTO CORAL REEF MANAGEMENT AND POLICY (Abstract ID: 28906)

Recent consensus on the new Anthropocene geological epoch marks widespread recognition of the permanent influence of Homo sapiens on planet Earth. Coral reefs are often cited as one of the most vulnerable ecosystems impacted by humans. The direct conduit from science to management is one of the most important tools we have for conserving coral reefs. Here I will discuss a number of ways in which the effectiveness of this nexus can be strengthened: 1) prioritizing research questions, ensuring that we are asking the right questions, or at least, not ignoring important ones; 2) getting the message right by incorporating nuance into public and policy debates; 3) expanding temporal perspectives to avoid misguided policies subject to shifted ecological baselines; 4) embracing and reporting uncertainty – anticipate not only what will happen when negative scientific predictions turn out to be true but also if they turn out to be false; 5) providing insight on potential biases; and 6) acknowledging the simultaneous effects of multiple stressors and the geographical variation in response to stressors. Recent studies of both Caribbean and Indo-Pacific reefs have shown one size doesn't fit all reefs for response to human activities and climate change. Incorporating these key concepts will allow coral reef scientists to serve the management and conservation community while maintaining scientific integrity, allowing the research community to continue to provide effective leadership in advising reef managers and environmental policymakers.

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THE STATUS OF REEF BENTHOS IN MARINE PROTECTED AREAS IN THE PHILIPPINES (Abstract ID: 28608 | Poster ID: 672)

Marine Protected Areas (MPAs) are popular tools to help rehabilitate marine habitats and conserve biodiversity. While MPAs primarily impact fish communities, the response of reef benthic components are less straightforward. MPAs benefit the reef benthos by lessening damage due to human activities. Also, MPAs help maintain healthy herbivore populations which control algae from dominating the reefs. Here we present the condition of the benthic communities from 27 municipalities in the Philippines. Benthic cover was derived using the line intercept transect methods in more than 260 50-m transects inside and outside 28 MPAs. Most of the MPAs were in the fair condition, with an average hard coral cover of 42.3%. While it is assumed that protection will lead to better coral condition, hard coral cover did not significantly differ among transects inside and outside the MPAs. Likewise, covers of other benthic components such dead coral, algae, etc. did not vary with respect to protection. Condition, mortality, development, and succession indices were also explored. Differences in reef benthos were detected across municipalities and biogeographic regions. This implies that factors driving variation in reef benthos operate at larger scales.

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CENTRAL PLACE REFUGING IN MARINE PREDATORS THAT NEVER SLEEP: EATING AT HOME AND AWAY (Abstract ID: 27998)

Central place refuging (CRF) is seen in a wide range of animals, including insects, fish and humans. In most cases the function of CRF is clear; the animal moves to/from a shelter or den site. CRF behavior is also seen in reef sharks, which swim continuously but would not seem to require a 'core' area to which they return. We used a combination of acoustic telemetry, biologging, and statistical modelling to understand potential drivers of CRF in reef sharks (blacktip and grey reef sharks) at an uninhabited atoll. Acceleration sensors and hidden Markov modelling identified crepuscular or nocturnal peaks in activity, but there was only a small increase in the probability of animals being active during peak periods. Animal-borne video cameras revealed that sharks would forage during the day on the reef, when they should be less active. We used acoustic telemetry with Brownian bridge models to generate 3D time-utilization distributions, which incorporated probability of activity, for individuals tracked over several years. Reef sharks showed strong residency to certain areas and displayed habitat shifts (diel) that did not necessarily match patterns of activity (e.g. crepuscular). Reef sharks essentially display CRF behavior that is counter to predictions as they forage both in their core area and likely their excursion habitats. The use of a core area may improve navigation especially if the animal uses reduced brain activity during the daytime as a replacement for 'sleep'. Future studies will investigate the implications of these behaviors to ecosystem predation effects and degrees of inter and intra-specific competition.

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GENETIC TYPING OF TRIDACNIDS AND THEIR ALGAL SYMBIONTS ON THE CENTRAL SAUDI COAST OF THE RED SEA (Abstract ID: 30144 | Poster ID: 57)

The Red Sea hosts a diverse community of coral reef organisms despite relatively extreme environmental conditions (high temperature and salinity). Due to these conditions, the Red Sea may offer insight to the capacity of reef fauna elsewhere to adapt to climate change. Tridacnids, a family of giant clams, are found throughout the Indo-Pacific, including within the Red Sea. This study examines the species diversity of giant clams and their algal symbionts from the central Saudi coast of the Red Sea using a combined morphological and molecular approach. Samples were collected at nine different reefs from both the sheltered and exposed sides of depths between 5 and 10 m. Results will be presented on whether or not reef side and type correlated with species diversity. A total of three potential species of tridacnids were found, but the majority were T. squamosa and T. maxima. Interestingly, we identified a group of genetically diverse tridacnids that could potentially be specific to the Red Sea. When examining the diversity of Symbiodinium, all samples were found to belong to clade A, which is common in Red Sea corals. Giant clams did not appear to be affected during a thermal bleaching event that took place

during this study, potentially due to the tolerance of the Symbiodinium. Further research on the role of Symbiodinium biodiversity and their interaction with giant clam hosts is necessary to understand the capacity of these and other photosymbiotic organisms to adapt in the face of climate change in the Red Sea.

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RECRUITMENT PULSES OF A BROODER DAMSELFISH, ACANTHOCHROMIS POLYACANTHUS IN PUJADA BAY, PHILIPPINES (Abstract ID: 29999 | Poster ID: 195)

The damsel brooder, Acanthochromis polyacanthus is one of the only two reef fishes with no pelagic larval duration. It has a narrow distribution ranging from GBR to Indonesia and all the way up to the southwestern portion of the Philippines. The recruitment pulses of A. polyacanthus was investigated to give light on how this particular species was able to disperse and attain its present distribution. Two stations in Pujada Bay (Tamisan and Catmunan Reefs) were surveyed monthly from January to November at 2 to 6 transects each. Tamisan Reef is exposed during the southwest monsoon (June to September) while Catmunan Reef is exposed during the northeast monsoon (November to March). A total of 1,792 recruits of A. polyacanthus was recorded for Catmunan Reef, whereas, only less than 50 individuals was observed in Tamisan Reef. However, the latter data was excluded in the analysis. Results showed significant difference across months with peak of recruitment from November to April covering two seasons in the Philippines, namely: northeast monsoon and the first month of weak easterlies (April-May). The pattern observed did not coincide with the known recruitment pulse in the Philippines which fall during the southwest monsoon and the second inter-monsoonal period (October). This suggests that the dispersal of A. polyacanthus most probably take place during the southwest monsoon, a non-breeding season for the species, through a stepping stone processes. More importantly, its distribution was confined within the net seawater mass movement during that period.

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BENEFITS AFFORDED TO REEF FISHES: GEAR RESTRICTIONS VERSUS REMOTENESS (Abstract ID: 28689)

It is well accepted that no take fishery closures provide refugia for fish and boost their overall abundance and biomass. In developing countries where people rely heavily on coastal resources for their daily subsistence, there is little evidence that no take areas are fully complied with or are different to gear restricted areas. Over the past 15 years, we monitored coral reef fish biomass from west to east Indonesia in response to management, including full fishing closures, fishing gear restrictions and in areas with no management. We also applied Indonesia national guidelines to rank the management effectiveness of Marine Protected Areas (MPAs). Across 466 sites representing 19 MPAs, and 3 unmanaged remote areas, we found a gradient in fish biomass ranging from 40 kg ha-1 in East Flores to 31,650 kg ha-1 in the remote area of Southwest Maluku. Across the gradient of sites from lowest to highest biomass we detected distinct changes in the trophic composition due to the relative percentage of planktivores and omnivores increasing. We also found full fishery closures had higher biomass than areas with gear restrictions, which in turn were generally higher than areas open to fishing. We examined the relationship between the management effectiveness rankings and fish biomass to see how well they correlated. Although we found the highest reef fish biomass in remote areas, and in some recently established MPAs, our study suggests that in areas close to human populations management efforts are contributing to improvements in Indonesian fish stocks.
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FINDING POTENTIALLY USEFUL REMOTE SENSING VARIABLES FOR A. PALMATA COVER PREDICTION (Abstract ID: 30082 | Poster ID: 540)

Acropora palmata is a key species conforming the structure of the Mesoamerican Coral Reef (MCR), sadly, a combination of factors have put it on the edge of extinction. That's why a periodic assessment of A. Palmata cover is a crucial part of an adequate monitoring of the MCR. To date, the only reliable method to estimate coral cover involves extensive fieldwork, which proves to be very expensive. It is then useful to test if other sources of information, like satellital images, could be used to lessen the cost of such assessments. We studied the distribution of various satellite derived variables (bottom reflectance, bathymetry and geomorphological zonation) conditional to percentage cover of A. Palmata, as a first attemp to identify remote sensing variables that can be important indicators of A. Palmata cover percentage. The study area is the national park "Arrecife de Puerto Morelos", which stands out for the highly conserved of some of its A. Palmata populations. We proceded by segmenting the area using the reflectance bands from a corrected WV2 image. After that, we used the information from an extensive fieldwork assessing Acropora cover to assign a level to each segment. Finally, we obtained the conditional distribution of the satellital variables per segment for each cover level. Results showed that spectral information per se is uncorrelated to A.palmata coverage. But complementary data like bathymetry and geomorphological features is not. We believe this is an important first step in the use of more powerful statistical techniques.

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REVERSING THE DECLINE: MODELING TARGETED CONNECTIVITY IN BAHAMIAN ACROPORIDS (Abstract ID: 29865)

Knowledge of the physical pathways among coral reefs created by the movement of water masses is usually considered essential for a causal explanation of the patterns of larval dispersal, retention, recruitment, and connectivity. Consequently, understanding physical pathways has implications not only for the design and the establishment of networks of coral reef marine reserves, but also for the selection of locations for facilitating the recovery of critically threatened broadcast spawners, such as elkhorn and staghorn corals. For this purpose, we set up a new HYCOM configuration for The Bahamas regional circulation with a 2km horizontal resolution and adapt the open-source Connectivity Modeling System to acroporid larval transport. Detailed habitat maps from satellite imagery collected at different spatial scales from 1-2m per pixel in some areas to 10-30m per pixel for the whole country are used to create a realistic coral reef landscape for the coupled biophysical model. Climate scenarios during years of contrasted hurricane occurrence serve to introduce maximum range of variability in connections. Sensitivity analyses on the role of specific larval traits and behaviors, such as swimming, increasing sinking rates with ontogeny, and temperature-related mortality rates, are performed to explore the detailed biophysical interactions that lead to source and sink variability, dispersal barriers, and temporally stable settlement nodes. We explore emerging temporal and spatial connectivity patterns and discuss results in the view of coral rehabilitation in a changing climate.
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RESILIENCE-BASED MANAGEMENT OF CORAL REEF ECOSYSTEMS: PAST, PRESENT AND FUTURE (Abstract ID: 28797)

The concept of resilience has been acknowledged as important to coral reef conservation for nearly three decades. However, we have struggled to demonstrate how resilience theory can be implemented to inform coral reef planning and management. Recent innovations in resilience-based management provide an approach to ecosystem-based management that is forward-looking, holistic and adaptive in nature, and address both current and future pressures including climate and non-climate threats. The NOAA Coral Reef Conservation Program is working with many partners including The Nature Conservancy, the Great Barrier Reef Marine Park Authority, the United Nations Environment Programme, academics and local managers around the world to advance the application of resilience-based management. These activities include science and research to better understand resilience, the development of data products and guidance to support the identification of resilience indicators, resilience assessments, and incorporation of resilience into planning and management decisions. Supporting resilience-based management is the priority of our climate-related work. This presentation will outline NOAA and partner contributions to this body of work, and will highlight priority next steps and progress made to integrate social and ecological resilience into coral reef management.

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FINE-SCALE TRANSCRIPTIONAL RESPONSES TO CLIMATE CHANGE IN THE ENDANGERED CARIBBEAN STAGHORN CORAL *ACROPORA CERVICORNIS* (Abstract ID: 27937)

Individuals adjust gene expression to acclimate to different stressors, while expression variation among individuals represents raw material available for adaptation via natural selection. Climate change will create more frequent sea surface temperature anomalies, especially in marginal regions such as the Florida Keys, but it is unclear to what extent hot and cold stressors will drive synergistic or antagonistic responses in individual coral colonies, and whether the adaptive capacity of coral populations will be enhanced or restricted due to periodic exposure to opposing temperature extremes. Taking advantage of three coral restoration nurseries that serve as long-term artificial common garden experiments, we exposed ten genetically distinct*Acropora cervicornis* colonies at each nursery to ambient, hot, and cold temperatures seasonally and measured typical gene expression responses using RNA-seq on pooled individuals. Targeting 21 genes of interest, including those with synergistic or antagonistic responses to hot and cold, we designed a high-throughput qPCR array to quantify expression in all 30 individuals under each treatment: a total of 360 samples. This study represents one of the most comprehensive investigations into fine-scale transcriptional differences within a coral species to date, and reveals extensive genetically- and environmentally-driven variation in acclimatory/adaptive capacity for a population endangered by climate change.

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COLONIZATION AND SUCCESSION OF HAWAIIAN GOLD CORAL (KULAMANA-MANA HAUMEAAE). (Abstract ID: 28750)

The Hawaiian gold coral is a parasitic zoanthid that colonizes other soft corals and secretes a protein skeleton that over millennia can more than double the mean height of the host colony. Visual surveys at 6 known coral beds in the Hawaiian Archipelago found mature gold coral to be a dominate taxa at all but the geologically youngest site. Less than 5% of the gold coral colonies seen were in the process of colonizing a host, described here as the "midas" phase. Bamboo coral (e.g. Acanella, Keratoisis) comprised 85% of the hosts of midas colonies with two thirds found at the younger site where the mean height of bamboo coral was significantly greater than at other sites. Marked midas colonies revisited after 5 and then 8 years showed the gold coral tissue spreading across the host at a rate of roughly 2 cm per year. Despite the rapid change much of the host skeleton is lost in the process of being subsumed. Cross-sections of mature gold colonies indicated the host comprises an average of 9.8 cm of the core of the gold coral stem. Midas colonies were notably absent from a bamboo coral assemblage growing on a 76-yr-old wreck adjacent (~1 km) to a patch of mature gold colonies indicating settlement was infrequent. This time lag between the bamboo coral host and the gold coral successor is essential because otherwise the speed of the midas phase would subsume the host population faster than it could replenish.

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A CASE STUDY IN GOOD GOVERNMENT: ORDNANCE REEF CORAL ASSESSMENT AND MITIGATION PROJECT (Abstract ID: 29660 | Poster ID: 686)

Discarded military munitions (DMM) represent a risk to human health and safety as well as the environment. Addressing these threats requires that a host of Federal entities (both military and civilian), State and Local agencies, and community stakeholders work together in a manner that maximizes efficiency and minimizes environmental impacts. Overcoming community distrust and skepticism to fully empower stakeholders to participate in public input sessions is crucial to ensuring effective community input and to achieving positive resource outcomes. The Department of Defense (DoD) is responsible for addressing the legacy of contamination associated with these munitions, including unexploded ordnance (UXO) present from current and former testing and training ranges and disposal of discarded military munitions (DMM). In an effort to evaluate remote means to recover munitions, the U.S. Army completed a demonstration of the Remotely Operated Underwater Munitions Recovery System (ROUMRS) in July 2011 to recover DMM present off the coast of Wai'anae, Oahu, HI. Working in collaboration with the DoD, the National Oceanic and Atmospheric Administration (NOAA) and the State of Hawaii surveyed corals and munitions present in the area prior to initiation of the recovery effort. This allowed for the demonstration project to be planned and executed in manner that minimized injury to corals present. Post-recovery surveys documented injury to corals that did occur and will allow for the design of a coral mitigation project appropriate for the injury that was identified. Details regarding the pre- and post- recovery surveys and coral assessment and mitigation process will be presented

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PATTERNS IN SOUNDSCAPES AROUND AUSTRALIA (Abstract ID: 29340)

Underwater soundscapes provide a wealth of information for resident, transient and settling fauna often using these cues for a number of independent or associated functions (e.g. mate selection, migration, recruitment). To researchers the sounds help assess presence, abundance, and distribution of vocal species, anthropogenic activity and resulting marine fauna responses. More recently, various acoustic components of a soundscape are being investigated as an index of habitat condition. However, restricted by technology, many previous studies relied on short-term sampling regimes, collecting only brief acoustic snapshots, increasing the likelihood of drawing uncertain conclusions on temporal patterns and soundscape composition. Over the last two decades, CMST has collected over 500, near-continuous (typically 5 of 15 minutes) long-term recordings at nearshore, offshore, reef and estuarine sites around Australia, collectively providing over a decade of coverage at some sites. This presentation will discuss several examples of soundscape spatial and temporal patterns in various biological contributions to soundscapes on a range of scales, some displaying significant day-to-day variations (up to shifts of hours between days). Many of these correlate with environmental drivers, such as temperature, salinity, tide, light or dissolved oxygen etc. Possible implications for short-term or snapshot datasets are discussed.
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RECONSTRUCTION OF THE HISTORY OF A ST. CROIX, USVI REEF LAGOON SYSTEM FROM THE SEDIMENTARY RECORD (Abstract ID: 29383)

Studies of ecosystem fidelity have shown that time-averaged molluscan death assemblages in surface sediments are representative of the living community on decadal scales. The assumption becomes that the death assemblage is preservable once buried beneath the surface, and can be used to reconstruct the history of the reef/lagoon system. Vibrocores through the entire sediment package (2-5m deep) revealed that the modern seagrass community is poorly represented in the subsurface. The lagoon is strongly bioturbated by callianassid shrimp that have reworked the sediment package such that it is nearly devoid of molluscs. Instead, there is a thick shelly lag deposit atop the Pleistocene substrate at the bottom of each core. Taxonomic analyses of the shells in the lag do not match the surface seagrass death assemblage. Instead, they are strongly skewed toward small infaunal bivalves matching open sandy environments in St. Croix lagoons. These results suggest one of two scenarios: 1) The typical seagrass community (epifaunal gastropods and larger, shallow infaunal bivalves) is not easily moved into the subsurface by callianassids, but remains at the sediment-water interface and degrades; or 2) the seagrass ecosystem is a relatively recent environmental change following a 7,000yr history of primarily open bioturbated sand. Applying taphonomic analyses to the mollusk assemblages avoids problems with taxonomic change over time. Taphonomy of the surface mollusks versus lag deposits supports the hypothesis that the lagoon has been dominated by open sand, not seagrass, throughout its history and therefore the lagoon has undergone a recent change from open sandy bottom to seagrass.

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DIVERSITY AND FUNCTION OF VIRUSES IN CORAL REEF SPONGES (Abstract ID: 28990)

Viruses are ubiquitous biological entities that regulate diverse biological processes. However, despite their abundance, we have limited knowledge about how viruses interact with marine invertebrate hosts, particularly with sponges, which are ecologically important components of coral reef environments. As marine holobionts, sponges harbour dense communities of microorganisms and this high symbiont complexity makes them an ideal model for studying host-virus interactions. Morphological and molecular approaches were used to describe the diversity and function of viruses in some of the most representative coral reef sponge species from the Great Barrier Reef and the Red Sea. Sponge viruses were isolated from their hosts, viral metagenomes were sequenced and taxonomic composition and function were assessed using a customized bioinformatic pipeline designed specifically for analysis of holobiont metaviromes. In addition, Transmission Electron Microscopy (TEM) was used to morphologically characterize the viral particles and resolve their spatial location within the holobiont. Initial molecular analyses indicate that sponges host a wide diversity of bacterial and eukaryotic viruses, including abundant Caudovirales and representatives of Mimiviridae, Phycodnaviridae and Iridoviridae. TEM analysis of different sponge species further revealed that distinct icosahedral virus-like particles were associated with both sponge and bacterial cells. This study highlights viruses as an important component of the sponge holobiont.

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MORPHOLOGICAL CHARACTERIZATION OF SPONGE-VIRUS ASSOCIATIONS USING TRANSMISSION ELECTRON MICROSCOPY (Abstract ID: 29234 | Poster ID: 498)

Viruses are among the most abundant organisms in marine ecosystems and play important roles in several biological processes. In this context, sponges are likely to be an important reservoir for viruses as they host a diverse array of macro and micro symbionts. Recent efforts have been made to improve and standardize methods for describing and quantifying viruses associated with other marine hosts such as corals. However, substantial technical challenges - e.g. the preparation of high quality transmission electron microscopy (TEM) images – have limited our understanding of sponge-associated viral communities. Here we assessed the efficacy of three different methods for TEM imaging of sponge-associated viruses: i) Viral purification from host tissue by cell lysis followed by ultracentrifugation in cesium chloride gradients to separate viruses based on density; ii) Ultracentrifugation of homogenized host tissue in liquid media directly onto Formvar-coated electron microscopy grids and iii) Preparation of ultrathin sections from the host tissue. To date, co-precipitates during ultracentrifugation have limited effective visualization of viruses although virus-like particles have been successfully observed in ultrathin sections of sponge tissue. Furthermore we successfully imaged viral-host interactions including the observation of inter- and intracellular viruses within the sponge holobiont.

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ISLAND EROSION AND MIGRATION IN HATOHOBEI STATE, PALAU (Abstract ID: 28261 | Poster ID: 392)

For small island nations, global warming and climate change has prompted predictions of disappearing islands swallowed by sea level rise. However, recent studies have shown dynamic reef island conditions over time, indicating that the situation is not so simple. Here, we assess the coastal changes on two remote and near-equatorial southwest islands of Palau using satellite imagery, historical aerial/coastal photographs, and GPS-based land surveys. Hatohobei (or Tobi) is an oceanic island surrounded by fringing reef and has experienced areas of both erosion and accretion of its coastal beach and land in past decades. Helen Reef is a medium-sized protected coral atoll with a single small sand spit island, an important turtle and bird nesting site. In the past 25 years Helen Reef Island has changed slightly in size and shape, but more critically has migrated sufficiently that only 10% of the island that was land in 1992 is still part of the present island. The island has literally "left behind" most of its larger vegetation so that in the last 25 years its general appearance has greatly changed. We examine changes of both islands relative to natural conditions and human influences and have attempted to obtain precise data that will allow detailed determination of changes in the future.

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LESSONS LEARNED FROM A QUARTER CENTURY OF A SUCCESSFUL MARINE CITIZEN SCIENCE PROGRAM (Abstract ID: 30027 | Poster ID: 721)

Since 1993, Reef Environmental Education Foundation (REEF) has coordinated the Volunteer Fish Survey Project, a citizen science program that engages divers and snorkelers to collect data. REEF surveyors record all positively identifiable fish species, along with categorical estimates of log-scale abundance. To date, approximately 16,000 volunteers have submitted over 200,000 surveys. Collectively, the surveys include over 8.5 million sightings records on over 3,400 species from 12,038 sites worldwide. All REEF data are made available to the public through summary reports via the REEF website. REEF also provides raw data files upon request. Scientists from government agencies and academic institutions use the REEF database to address management and conservation issues, including fisheries assessments, evaluation of species trends, understanding ecological patterns, tracking non-native species, and identification of new species. Over forty scientific publications have included REEF data. To ensure a high level of accuracy, REEF staff have incorporated layers of quality assurance, including experience levels, automated error checking during submission, and extensive post-processing. Several recently published papers have developed analyses that capitalize on the power of the data collected while addressing uncertainty. Based on experiences in the development, cultivation, and expansion of the REEF program, I will discuss characteristics that foster long-term participation and generation of data that have proven useful for marine conservation and discovery.
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CO-MANAGEMENT TO ADDRESS LIVELIHOOD LINKED THREATS TO CORAL REEFS – CASE STUDY FROM GULF OF MANNAR, SOUTHEASTERN INDIA (Abstract ID: 29116)

The fishers live along the coast of Gulf of Mannar depend mainly on the fishery resources for their livelihood. Though reefs in Gulf of Mannar are protected, there is good accessibility for coastal communities. The steady increase of population (34% in 15 years), crafts and competition forced them to diversify into shore seine fisheries, trap fishing and poaching of ornamental fishes in reef areas. The 2004 Indian Ocean Tsunami made the community significantly more aware of the importance of reefs. The increase of additional livelihood options through eco development activities under various national and international programmes like CORDIO, GCRMN, GEF-UNDP also helped the fishers to reduce their dependence on the sea. However, nowadays the cultivation of exotic seaweed, Kappaphycus alvarezii and seaweed collection in reef areas have inflicted considerable damage to reefs. Due to invasion of exotic seaweed, about 1.2 Km2 reef areas have been affected and seaweed collection makes regular disturbances to reefs.. These activities are not permitted as per Wildlife Protection Act of India and respective Government Orders, however the activities are linked to livelihood of over 600 fisher families and there was always conflicts between community and reef managers on this issues. The Government through a GEF-UNDP project with 252 grass root level organizations - Village Marine Conservation (VMC) and Eco Development Committees (EDC) have been formed and loans are provided as revolving fund to enhance their livelihood activities and to reduce pressure on reefs.
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A NEW SPATIO-TEMPORAL RECORD OF BIOEROSION IN DEGLACIAL FOSSIL REEF SEQUENCES FROM IODP EXPEDITION 325 CORES, GREAT BARRIER REEF, AUSTRALIA (Abstract ID: 29133)

Bioerosion traces preserved in coral reef systems provide insight into past environmental conditions and reef health, however few studies have explored this in fossil reefs. The International Ocean Drilling Program (IODP) Expedition 325 sampled fossil Last Glacial Maximum (LGM) to deglacial (~10-30 ka) reef sequences off the northwest continental shelf of the Great Barrier Reef. Presence of bioerosion traces (*ichnogenera*: *Entobia*(Sponges), *Gastrochaenolites* (Bivalves) and *Maeandropolydora*/*Trypanites*(Worms)) was quantified based on detailed core observations and high-resolution 3D CT data from 14 drill holes from 3 cross-shelf transects within two regions, Hydrographers Passage and Noggin Pass. A new high-resolution temporal record of bioerosion activity was defined from the cores using a comprehensive chronologic database. This new record, along with paleo-environmental interpretations derived from coralgal assemblage data, were used to study multi-scale spatio-temporal patterns of bioerosion across-shelf, along-shelf and within individual sites. Pooled bioerosion data show temporal differences in relative abundance and intensity, which is consistent with

position of major reef sequence boundaries, including shallow reef death events. Bioerosion intensities vary between both regions possibly inferring distinct post-depositional environmental settings. Finally, we discuss the influence of bioerosion on reef systems during periods of rapid environmental change (last deglaciation) when environmental conditions were very different from now.

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ELECTRICAL NETWORK MODELING OF PERFORATE AND IMPERFORATE CORAL PHYSIOLOGICAL PERFORMANCE UNDER ENVIRONMENTAL STRESS (Abstract ID: 29066 | Poster ID: 355)

Scleractinian coral body plan potentially affects resource sharing and response to stress that can lead to bleaching. We use electrical network models, where resistance, capacitance, voltage, and current have identifiable correlates with organism structures and the environment. Perforate taxa share a common gastrovascular system connecting all polyps. In imperforate taxa, a colony's polyps are connected only to nearest neighbors (in a hexagonal array) and only when the colony is expanded. We present microelectrode data for dissolved oxygen inside and around imperforate (Montastraea cavernosa) and perforate (Acropora cervicornis) colonies in no flow and flow conditions (colony Reynolds number = 4,000 and 10,000), and morphological data, used to estimate parameters for a resistance-capacitance network model of mass transfer between colonies and the environment. SPICE network simulations of the performance of perforate and imperforate models of colonies of varying size exhibit strikingly different dynamic behaviors to environmental perturbations. Perforate coral colonies exhibit larger time constants, on the order of many minutes, for response to environmental perturbation compared to imperforate species, which have faster system dynamics but uncouple neighboring polyps from each other. A key parameter requiring further characterization is the mixing time constant of the polyp coelenteron. Ecophysiological network models of resource sharing are useful in predicting response to changing environmental conditions.
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EFFECTS OF TEMPERATURE AND SALINITY ON CORAL BLEACHING UNDER LABORATORY CONDITIONS. (Abstract ID: 29526 | Poster ID: 415)

Coral bleaching occurs when cell densities or/and cellular content of photosynthetic pigments in zooxanthellae are decreased which may due to some environment stresses espeacially under conditions of elevated temperature and low water salinity or a combination of these factors. To clarify the important role of temperature and salinity on coral bleaching, this study has been conducted in the cauliflower coral, *Pocilloporadamicornis* collected from Samaesan Island, Chonburi, Thailand. The same size of cauliflower coral's colonies were collected and placed in wide mouthed glass jar at temperature of 28, 31 and 34 C. For each temperature level, there were 3 levels of salinity experiments 10, 20 and 33 psu. The percentage of bleaching in cauliflower coral's colonies were observed in conjunction with the cell densities of zooxanthellae in seawater of the glass jar. Sampling cells were enumerated every 3 hours for 33 hours. High cell density of zooxanthellae was found the glass jar seawater and coral bleaching (50% of coral colony) were observed only in the low salinity (10 psu) at 28 and 31 C. On the other hand all coral colonies were bleached at 34 C in all salinity levels. These results suggested that high temperature and low salinity play an important role on coral bleaching.

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DECIPHERING CHEMICAL SIGNALING IN BLACK BAND DISEASE (Abstract ID: 29919)

Black Band Disease (BBD) is the first reported coral disease and the most widely distributed polymicrobial disease of corals. In BBD, a polymicrobial disease consortium dominated by the filamentous cyanobacterium*Roseofilum reptotaenium* displaces members of the epibiotic microbiome. We investigated the natural products chemistry and chemical ecology of BBD and nonaxenic cultures of *R. reptotaenium*. Within the BBD consortium, we identified lyngbic acid, a cyanobacterial secondary metabolite. It strongly inhibited quorum sensing (QS) in the *Vibrio harveyi*QS reporters, which depend on the presence of the CAI-1 receptor CqsS. Lyngbic acid inhibited luminescence in native coral *Vibrio* spp. that also possess CAI-1-mediated QS. *R. reptotaenium* also produces a novel malyngamide. Since malyngamides from other cyanobacteria are known to inhibit QS activity we also examined the functions of this new compound. The effects of these naturally occurring QS inhibitors on bacterial regulatory networks potentially contribute to the structuring of interactions within BBD consortia.

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WHAT IS THE BEST SCIENTIFIC JUSTIFICATION FOR MPAS ON CARIBBEAN REEFS? (Abstract ID: 27853 | Poster ID: 653)

Marine protected areas (MPAs) are a common policy tool used for the conservation of coral reefs worldwide. The scientific justification for MPAs is based on community-level indirect effects of overfishing on the competitive interactions between seaweeds and reef-building corals: more fishing, more seaweeds, less coral. Some have questioned this justification for MPAs in the Caribbean, which has reefs that are distinct from those found elsewhere in the tropics. We found an explicit indirect effect of overfishing on competition between sponges and reef-building corals from surveys of 69 sites across the Caribbean. Removal of sponge-eating angelfishes and parrotfishes resulted in > 3 fold increase in overgrowth of corals by sponges, with coral-sponge contact increasing from 11.0% to 25.6%, and these sponges were mostly species palatable to sponge predators. Palatable sponge species have faster rates of growth or reproduction than defended species, which instead make metabolically expensive chemical defenses. Surprisingly, overfished sites had lower seaweed cover, contrary to prevailing assumptions about seaweed control by herbivorous fishes. Coral-sponge competition provides an unambiguous justification for MPAs in the Caribbean, while seaweed cover does not.
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HYBRIDISATION AMONG GROUPERS (GENUS CEPHALOPHOLIS) AT THE EASTERN INDIAN OCEAN SUTURE ZONE: TAXONOMIC AND EVOLUTIONARY IMPLICATIONS (Abstract ID: 28560)

A suture zone in the eastern Indian Ocean is home to numerous hybridising species, providing an opportunity to determine how hybridisation affects speciation and biodiversity in coral reef fishes. At this location, hybridisation between two grouper: Cephalopholis urodeta (Pacific Ocean) and C. nigripinnis (Indian Ocean) was investigated to determine the genetic basis of hybridisation, and to compare the ecology and life history of hybrids and their parent species. This approach aimed to provide insights into the taxonomic and evolutionary consequences of hybridisation. Despite clear phenotypic differences, hybrids and their parent species were genetically homogenous within and (thousands of kilometres) outside of the hybrid zone. Hybrids were at least as fit as their parent species (in terms of growth, reproduction and abundance) and were observed in a broad range of phenotypes. The two species appear to be interbreeding due to inherent biological and ecological similarities and the lack of genetic structure may be explained by three potential scenarios: 1) hybridisation and introgression; 2) discordance between colouration and genetics; and 3) incomplete lineage sorting. Further genetic analyses may be necessary to distinguish these scenarios. Regardless, the two species are unlikely to evolve in reproductive isolation as they cohabit at Christmas Island and will source congeneric mates at Cocos (Keeling) Islands. Our results suggest that hybridisation among coral reef fishes is a dynamic evolutionary factor.

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RESPONSES OF COMPLEX VS ROBUST CLADE CORALS FROM HIGH LATITUDE SOUTH AFRICAN REEFS TO WARMING AND ACIDIFICATION. (Abstract ID: 28634)

The high latitude reefs of South Africa's Maputaland coast are considered marginal as they are at the extremes of coral distribution. They are, however, extremely vibrant and biodiverse ecosystems with a high biodiversity including >90 hard and >40 soft coral species. These corals occur at the lower ranges of their thermal tolerances and are subject to significant seasonal variation, suggesting that they might have greater capacity for thermal acclimation than tropical conspecifics. Indeed, the Maputaland reefs were

not affected by the global coral bleaching events in 1998 and 2010 that significantly affected many other reefs in the Western Indian Ocean. The basis for this may lie in the abilities of the corals to acclimate or could be due to local physical and oceanographic features that reduce exposure to thermal stress. In order to investigate the potential for acclimation to current and future stresses, representative local corals from the complex (*Acropora austera*) and robust clade (*Hydnophora exesa*) were exposed to preindustrial, current and future temperatures and pH in a multifactorial design. Physiological changes were observed with changing temperature but not pH. Tag-based RNA-Seq was used to determine differential transcriptional responses to temperature and pH. This entailed assembling the full transcriptomes of the target species, which are the first corals from the highly diverse WIO and one of the few species from the robust clade to be sequenced. As such they are also of great interest for evolutionary studies.

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THE INFLUENCE OF HABITAT AND CONSPECIFIC ADULTS ON THE ABUNDANCE AND SPATIAL DISTRIBUTION OF JUVENILE CORALS (Abstract ID: 29941)

Despite an increased understanding of recruitment and population dynamics of stony corals, there is a lack of knowledge on how various mechanisms may influence or create spatial patterns within a population, mainly due to methodological limitations. We use photomosaic images created by stitching together thousands of individual images, giving us the opportunity to look at how processes operate on a broader spatial scale. At eight sites on the forereef of Palmyra Atoll, photomosaics (100 $m^2$ in size) were used to identify and digitize all juvenile (<5 cm diameter) and adult coral colonies. Using various metrics such as density, percent cover, and the position of each colony, we examined relationships between juveniles and adults in terms of abundance and spatial patterning. Our results show that juvenile density is more strongly related to adult density rather than adult percent cover (by genus). Additionally, we found that juveniles of some genera were associated with specific habitat characteristics (consolidated versus unconsolidated substrata). A look at the spatial relationship between juveniles and adults using mean nearest neighbor distances shows three genera in which juveniles were clumped around adults of the same genus, while all other genera were randomly distributed with respect to adults. Using spatial patterns, this study provides insight into the potential role adult reproduction and settlement preferences play on the early life stages of corals.

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POPULATION STRUCTURE AND MIGRATION PATTERNS OF THE CORAL *MUSSISMILIA HISPIDA* ALONG THE SOUTHWESTERN ATLANTIC OCEAN (Abstract ID: 29389 | Poster ID: 185)

The Brazilian coast encompasses the only true coral reefs from the Southwestern Atlantic Ocean, with a unique coral fauna characterized by low diversity and a high percentage of endemics. *Mussismilia hispida* is an endemic coral and one of the main reef builders, having one of the broadest distributions along the coast. Although important, there are no estimations of its population structure, even with reproductive asynchrony being observed among localities. This study aimed at estimating the population structure and patterns of migration for *M. hispida*, at 15 sites along its distributional range, using 13 microsatellites loci. Results show that *M. hispida* can be divided into five genetically structured populations: Northern region (NR), Oceanic islands (OI), Central region (CR), Southeastern region (SER) and Southern Limit (SL). Reproductive asynchrony does not seem to explain the observed patterns of gene flow. The CR and OI were the most genetically diverse populations, while SL had the lowest diversity. The migration model that best explained gene flow among populations was the one where OI exports migrants to NR and CR, CR exports migrants to the OI and SER and the latter exports migrants to SL. This pattern is mostly consistent with the main oceanic currents in the area. This is the first study to assess population structure and gene flow of a coral species along the Southwestern Atlantic coast using a highly variable marker. Results are useful for Brazilian coral reef conservation management strategies.

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SOCMON CARIBBEAN AND COMPREHENSIVE INTEGRATED MONITORING (Abstract ID: 27955)

The Caribbean node of the Global Socio-economic Monitoring Initiative for Coastal Management (SocMon) has been developing regional capacity in socio-economic monitoring since 2003. Site assessments are tailored to site needs with study goals and objectives aligned to relevant management plans and/or management questions. Assessment data are often compared to socio-economic and ecological secondary data in order to better understand socio-economic impacts and explain trends in socio-economic characteristics. However, SocMon has never been deliberately incorporated into biophysical monitoring until recently. SocMon is one of the most widely recognised methodologies for human dimensions monitoring in the Caribbean region due in part to (1) its institutional base at the University of the West Indies, Barbados, and (2) the number of sites at which it has been implemented. Consequently, large conservation organisations and global monitoring initiatives recognise its value and have demonstrated interest in incorporating the methodology as needed to achieve relevant resource conservation and management goals. The Nature Conservancy's (TNC) Eastern Caribbean Marine Managed Areas Network (ECMMAN) Project and the Caribbean arm of the Global Coral Reef Monitoring Initiative (GCRMN-Caribbean) have both adopted SocMon as the socio-economic monitoring methodology of choice for integrated coastal and coral reef monitoring. This presentation demonstrates progress towards integrated comprehensive monitoring in the region through the ECMMAN Project and GCRMN-Caribbean.

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MASSIVE BLEACHING IN THE CORAL TRIANGLE: THE OCCURRENCE OF SURFACE WARMING ANOMALIES AND POSSIBLE CONNECTION TO OTHER PHYSICAL PARAMETERS (Abstract ID: 28138)

There have been two major recorded bleaching events in the Coral Triangle, in 1998 and 2010. Both events coincided with a La Nina event. However, we noted that other La Nina events and anomalous warming have occurred between these two years with no corresponding massive bleaching reports. This prompted this study which investigates the patterns in the timing and extent of anomalies from 1997 to 2010 of some parameters thought to be associated with coral bleaching occurrences. These parameters include SST, wind speed, cloudiness and PAR. The ITCZ latitude position is also included since this parameter is said to be affected by ENSO and might provide additional insight to the process that favors coral bleaching occurrence. Time-latitude plot of SST anomaly shows a more extensive warming in the Coral Triangle in 1998 than 2010. Investigations show an intense decrease in cloudiness and an increase in PAR can also be observed prior to the intense increase in SST in those two years. A strong drop in the wind speed as the ITCZ mean latitude shifts southwards is also seen to coincide with the 1998 and 2010 SST anomaly. The long duration of intense negative anomaly in ITCZ latitude position likely hindered the monsoonal winds in the Coral Triangle in those times. We contend therefore, that conditions of low cloud, high PAR, high SST, and low wind, favored the occurrence of mass coral bleaching. The combination of conditions can likely occur in the Coral Triangle if a strong/moderate El Niño is followed by a strong/moderate La Niña.

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CORAL REEFS AND PEOPLE IN A HIGH CO2 WORLD: WHERE CAN SCIENCE MAKE A DIFFERENCE TO PEOPLE? (Abstract ID: 27858)

Increasing levels of CO2 put shallow water coral reefs, and the people who depend upon them at risk from two key global stresses: elevated sea surface temperature, and ocean acidification. These global stresses cannot be avoided by local management, compound local stresses and hasten the loss of ecosystem services. Impacts to people will be most grave where human dependence on coral reefs is high, sea surface temperature reaches critical levels soonest, and ocean acidification levels are most severe. Where these elements align, swift action will be needed to protect people's lives and livelihoods. Designing policies to offset potential harm to coral reefs and people requires a better understanding of where CO2-related global stresses could cause the most severe impacts. To identify where people are at risk and where more science is needed, we integrate spatially-explicit indicators from biological, physical and social sciences to map human dependence on the coral reefs and the globally-driven threats to corals from a high-CO2 world. Western Mexico, Micronesia, Indonesia and parts of Australia have high human dependence and will likely face severe combined threats. As a region, Southeast Asia is particularly at risk. These areas require new data and interdisciplinary scientific research to help coral reef-dependent human communities better cope with, prepare for, and adapt to increasing atmospheric CO2. Many of the countries most dependent upon coral reefs are also the countries for which we have the least robust data on ocean acidification.

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WHAT'S A CLEAN BEACH WORTH: RECREATIONALIST WILLINGNESS TO PAY FOR COASTAL WATER QUALITY AND ATTRIBUTES (Abstract ID: 29662)

Like many places across the world, corals in Hawaii are under threat from anthropogenic degradation, with significant economic costs to human welfare. To understand the economic implications of coral reef degradation in Hawaii's coastal waters, we undertook a non-market valuation. We used a discrete choice experiment to capture recreationalists' preferences for coastal water, coral, and fish attributes. Each attribute had three levels (low, medium, and high). We conducted in-person surveys with 263 beach users from June-November 2014 across a representative sample of Oahu's beaches staffed by lifeguards. For each beach visit, analysis of a mixed logit model suggests an individual is willing to pay approximately $17.17 to reduce days of bacterial exceedance from 11 to 5 per year, a further $19.76 to reduce it to no bacterial exceedances at all. WTP to move from 15 ft to 30 ft of underwater visibility was $29.99, a further $9.85 to increase from 30 ft to 60 ft. Respondents were willing to pay $13.97 to improve coral reef cover from 10% to 25%, a further $3.75 to improve to 45% cover. WTP for moving from 9 species in the environment to 18 species in terms of fish diversity was $11.79, a further $0.82 to increase that to 27 fish species. Our results provide critical information for resource managers and policy makers about the economic costs of water quality and coral decline. While dollar amounts may not fully represent the richness of natural resources and the diversity of ecosystems, valuation can help ensure environmental goods are considered alongside competing interests

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MANAGING RECREATIONAL DIVING IN TEMPORARY CLOSURES FOLLOWING THE 2010 CORAL BLEACHING EVENT IN THE ANDAMAN SEA (Abstract ID: 29302 | Poster ID: 662)

The severe coral bleaching events have led to coral mortality in many dive sites of Thailand. This study focused on appropriate management strategies for degraded recreational dive sites following the 2010 coral bleaching event in a marine national park in the Andaman Sea. Management strategies for recreational dive sites that were proposed and implemented were prevention of coral damage from snorkeling in the shallow reefs through the use of life vests, reduction of sediment load from coastal development and wastewater discharges, temporary closure of selected dive sites, establishing new dive sites, conducting research and monitoring program for coral conservation and restoration and establishing effective networks of relevant agencies. Popular dive sites in marine national parks have been temporarily closed since 2010, in order to build resilience and to enhance coral recovery. The long-term coral reef monitoring program showed that live coral covers at both dive sites increased slightly over the last five years. However, coral recruitment rates were low. As numbers of recreational divers in the Andaman Sea are increasing, the Mu Ko Similan National Park management are considering establishing new dive sites in the park. However we recommend that active coral restoration in small controlled areas for recreational diving should be carried out instead of creating new dive sites. Raising public awareness is required intensely for coral reef conservation in Thailand in the period of increasing human and climate change impacts.
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COLONY SIZE AND STRUCTURE AS DETERMINANTS OF HABITAT USE AND FITNESS OF CORAL-DWELLING FISHES (Abstract ID: 27951)

Competition for space affects patterns of habitat use and individual performance of coral-dwelling fishes; however, the physical attributes of corals that influence habitat preferences are uncertain. We investigated the influence of coral colony size and branching structure on habitat use and growth rate of two coral gobies, Gobiodon histrio and Gobiodon erythrospilus. First, we examined two key aspects of coral colony structure, interbranch depth and interbranch width that may influence habitat preferences. We then used laboratory and field-based experiments to test the effects of coral species, coral colony size and branching structure on habitat preference and growth rates of two gobies. The preferred coral species, A. nasuta had smaller interbranch width than A. spathulata. A laboratory experiment demonstrated that both gobies preferred colonies with smaller interbranch width, except when they had the opportunity to occupy A. nasuta over A. spathulata. A field experiment showed that both goby species grew faster on larger coral colonies and in colonies with smaller interbranch width. G. erythrospilus grew faster than G. histrio on A. spathulata, indicating that it suffers less of a fitness loss occupying this alternative habitat. Our results show that coral physical attributes are important factors driving habitat preference of coral-dwelling gobies; however, there must also be additional factors that influence their habitat use. Declining average coral size and reduced habitat complexity on coral reefs could have significant impacts on the performance of fishes.
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CONDITION ASSESSMENT OF CORAL REEFS OF TWO MARINE PROTECTED AREAS UNDER DIFFERENT REGIMES OF USE IN THE NORTH-WESTERN CARIBBEAN (Abstract ID: 28359 | Poster ID: 631)

We assess the conditions of reefs of two MPAs in the Caribbean: Guanahacabibes National Park (GNP), Cuba and Costa Occidental Isla Mujeres-Punta Cancun-Punta Nizuc National Park (CNP), Mexico, in 2014. The reefs (two per MPA) undergo different diving intensities. The indicators analyzed for corals in transects of 10 m were cover, diameter of colonies and old and recent mortality. The abundance of coral recruits and black sea urchin were assessed in 1m2 quadrats and the cover of macroalgae in 25x25 cm quadrats. We detected different stages of the path that have been following the Caribbean reefs to a change in dominance of coral species and the deterioration of the 3-dimensional structure. Cuevones (closed to tourism for 15 years) in CNP seems to remain dominated by corals, with high cover (33.36%), but with a species dominance (headed by Porites astreoides), different from the observed in Caribbean reefs few decades ago. Reefs of GNP subjected to a low diving intensity appear to be experiencing the beginning of a shift phase to be dominated by macroalgae. However, the coral cover remains similar to previous reports (Yemaya 18.3%, Laberinto 12.1% ) and the density of recruits (Yemaya 5.02 recruits/m2, Laberinto 4.67 recruits/m2 ) was high, typical of healthy reefs, so there may still be hope of conservation for these sites. Manchones, CNP, showed the lowest coral cover (11.49%) and the lowest recruit density (0,6 recruits/m2), probably due to the joint action of natural pressures that Caribbean reefs are subjected and to the heavy influx of visitors the reefs receive.

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VARIABILITY OF CORAL REEF PRIMARY PRODUCTION AND CALCIFICATION COMPLICATES SCALING UP RATES ON HERON ISLAND REEF FLAT IN SOUTHERN GREAT BARRIER REEF, AUSTRALIA (Abstract ID: 28419 | Poster ID: 109)

Measuring and monitoring primary production (P) and calcification (G) of coral reefs has become increasingly important to understand how and why coral reefs are changing due to natural and human factors. This study assessed three sites with different surface cover composition within the western reef flat around Heron Island, southern Great Barrier Reef to test flow respirometry methods to measure net primary production and calcification in July 2015. Differences in P and G were apparent between sites measured, which could be explained by differences in benthic community composition. Net P and G were highest for the live coral dominated areas to the north-west of the island with -137.24 mmol C m^2/hr and 38.04 mmol CaCO3 m^2/hr, respectively. East of the island, was second highest with –72.61 mmol C m^2/hr and 9.26 mmol CaCO3 m^2/hr, and was characterized by sandy area with patches of coral, macroalgae, and microphytobenthos. The lowest net P and G rates were directly south of the island with –11.45 mmol C m^2/hr and 0.45 mmol CaCO3 m^2/hr, which is a sandy area with sparse live coral, macroalgae, and microphytobenthos. Due to variability in reef metabolism and calcification which are dependent on benthic community type, care must be taken for scaling processes across entire reef systems that do not account for such variability within a geomorphic zone. This presentation will further discuss alternative approaches to linearly upscaling field measurements through application of a model to estimate variable rates of primary productivity and calcification.

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MORPHOMETRIC ANALYSIS OF OTOLITH SHAPE VARIATION IN SIGANUS FUSCESCENS (HOUTTUYN, 1782) FROM THE WEST AND NORTHERN PHILIPPINE SEA (Abstract ID: 29033 | Poster ID: 250)

Otolith shape is affected by several factors including fish growth, genetic variations, and diverse environmental conditions. As such, otolith shape analyses have proven to be a promising tool for stock identification. The capacity to isolate stocks of commercially important species is vital for the development of site-specific fisheries management and conservation schemes. However, separating fish stocks using otolith shape have yet to be explored for Philippine basins. This study aims to address this data gap by analyzing the effect of environmental conditions and fish growth on otolith shape by comparing the otolith shapes of Siganus fuscescens specimens from the West and Northern Philippine Sea. In the study, otolith shape was analyzed in two ways: (a) traditional morphometrics, where linear distances traversing the otolith are associated with head measurements, and (b) geometric morphometrics, where landmarks and semi-landmarks are used to outline and quantify the boundary of the otolith. Variations in otolith shape was analyzed using thin-plate spline transformations. At present, the initial batch of otolith specimens analyzed through geometric morphometrics showed noticeable differences in otolith shape between populations from the West and Northern Philippine Sea. In contrast, only slight variation in otolith shape between populations within the West Philippine Sea biogeographic region was observed. This is in agreement with the stock-specific variations in body shape of S. fuscesens in these basins. Furthermore, validation of these results via genetic analysis could establish otolith shape as a cost effective alternative in separating S. fuscescens stocks.

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THE STODDART SOCIETY: LONG-TERM RESEARCH ON THE ECOLOGY AND CONSERVATION BIOLOGY OF LIGHTHOUSE REEF ATOLL, BELIZE (Abstract ID: 29825)

In the early 1960s, David Stoddart conducted the first surveys detailing the flora, fauna, and geology of the three Caribbean atolls, including Lighthouse Reef (LHR), about 45 miles off the coast of Belize. Stoddard's descriptions of the ecological distributions of the marine, intertidal, and terrestrial organisms created a baseline for future scientists to compare how oceanographic, atmospheric, and anthropogenic stresses have come to shape the current community structures at LHR through time. Revisiting some of Stoddard's transects more than 50 years later, we have begun to understand which species have shifted their habitats, some expanding and some decreasing their distributions. Three years ago, The Stoddart Society, as our Ecology and Conservation Biology of Coral Reefs course at Wake Forest University has become informally known, began visiting LHR each March to conduct annual surveys documenting the current diversity and abundance of the flora and fauna. Using methods established by Coral Watch and REEF, we have increased the number of field sites to survey the coral health and fish populations across the atoll. By taking undergraduate students to the reef and teaching them various techniques to study the flora and fauna at LHR, along with increasing our efforts to include local NGOs and students from the University of Belize, we will continue to promote the conservation and appropriate management necessary to sustain this coral reef ecosystem and its services.

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SIZING UP METABOLIC HETEROGENEITY AT SINGLE CELL LEVEL: TOWARDS A FUNCTIONAL UNDERSTANDING OF OPTICAL MICRONICHES IN CORAL SYMBIOSIS (Abstract ID: 28904 | Poster ID: 94)

Tropical marine ecosystems based on reef-building corals are among the most productive marine ecosystems on Earth. At the heart of the success of corals as ecosystem is their mutualistic symbiosis with dinoflagellate algae from the genus Symbiodinium – which provides enormous amounts of energy to the anthozoan host. Previous studies have revealed the presence of steep light gradients in tissues of corals. Yet, it is unknown whether such resource stratification allows for physiological differences of Symbiodinium across optical microniches within coral tissues. In this talk, we emphasize the potential of combining single cell metabolomics with stable isotope labelling and microsensors measurement to study the metabolic activity of individual Symbiodinium cells along microscale gradients of light within coral tissue. Our results demonstrate the functional diversity of Symbiodinium along microscale gradients in the coral tissue, where carbon fixation varied about six-fold depending on the local light levels. Further, our data suggest substantial differences in light utilisation efficiency along the coral tissue light microgradient. These results could have important consequences for coral responses to environmental stress as they suggest the presence of physiologically distinct populations of Symbiodinium, that could act as a reservoir of variation, providing selective advantage to corals exposed to or recovering from environmental stress.

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CHANGING DYNAMICS OF CORAL REEF CARBONATE PRODUCTION AND IMPLICATIONS FOR FUTURE REEF GROWTH POTENTIAL (Abstract ID: 27816)

Coral cover is rapidly declining globally, and coral species assemblages changing. Although poorly quantified these changes are projected to lead to lower carbonate production rates and thus reduced reef growth potential. Using data from sites in the Caribbean and Indian Ocean which have undergone different post-disturbance ecological trajectories over the last 20-30 years, the differential impacts of disturbance on carbonate production regimes and on resultant reef growth potential can be explored. In the Caribbean, a region which has undergone major ecological change, average carbonate production rates are now less than 50% of pre-disturbance rates. In contrast, the budgets of many reefs across the Chagos archipelago (central Indian Ocean), which is geographically remote and largely isolated from direct human disturbances, have recovered rapidly from the 1998 coral bleaching event. The carbonate budgets on these reefs average +3.7 G (G = kg CaCO3 m-2 yr-1) and are especially high on Acropora-dominated reefs (average +8.4 G). These budget data provide a basis for estimating vertical reef growth potential (mm yr-1). Although addition data are urgently needed to parameterise reef growth rate estimates, current best-estimates point to marked inter-site variability. Across the Caribbean the growth potential of most reefs is probably insufficient to track future sea-level rise. In contrast, rates measured across the more geographically remote Indian Ocean reefs suggest a more positive prognosis – albeit one that is dependent on the maintenance of high Acropora coral cover.

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THE MYTH OF THE "HEALTHY" CORAL: THE NEED FOR PHENOTYPIC ANCHORING BEFORE AND DURING THE AGE OF 'OMICS (Abstract ID: 28164)

A fundamental problem in the study of corals and other reef organisms is the difficulty in determining their health, which may lead to incorrect conclusions about the results of observations and experiments. Studying cells and tissues using microscopy helps us understand how the structures formed by molecules function and allows us to detect changes in structure that are related to functional impairment (disease). The use of histopathological examinations and clinical diagnostic assays continues to be overlooked in studies on these organisms. Corals that meet visual criteria as healthy may actually contain microscopic lesions, parasites, or pathogenic microorganisms that affect their metabolism and the interpretation of molecular analyses. The tissue loss diseases in Caribbean acroporids first seen in the 1970s are now known to be influenced by chronic infection of polyp mucocytes with a rickettsia-like organism. Coral bleaching and hyperpigmentation can be subtle and have multiple causes, but the use of spectral imaging paired with microscopy may provide non-invasive health screening techniques.

Interactions of coral polyps with endolithic fungi deep in the skeleton can be limited and benign, but in other cases environmental stimulation of fungal hyphae leads to basal body wall necrosis and loss of gonads. Clinical and diagnostic methodologies support evidence-based human and veterinary medicine; microscopic tissue examinations can also contribute descriptive and mechanistic data to identify causes of organism decline and focus management efforts to conserve coral reefs.

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ASSISTED RECOVERY OF DEGRADED REEFS: CORAL RESTORATION WITHOUT THE NEED FOR TRANSPLANTATION (Abstract ID: 28312)

Current reef rehabilitation practices involving coral transplantation are labor and cost intensive since each individual must be reared to a suitable size and transplanted manually. These constraints have limited the scale of most restoration efforts to less than a hectare, while reef degradation occurs on scales of 10's to 1000's of km2. We introduce a new concept to seed larger areas of reef with sexually reared coral juveniles bypassing the need for transplantation. Following the concept of a farmer bedding out seedlings on a field, sexual coral propagules settled on engineered substrates (=SExual COral REproduction Seeding Unit, SECORE SU) and reared in a nursery for a short time period are introduced to the reef by wedging them in reef crevices without the use of any adhesives. This concept was initially tested in Curacao with the brooding coral Favia fragum using tetrapod-like shaped cement substrates. Three weeks after larval settlement and after an intermediate ex-situ hatching period, SUs were introduced to reef areas of varying structural complexity. Substrate stabilization, recruit survival and SU performance were monitored for 1 year. After 1 year, 70-81% of the tetrapods were recovered across all reef complexity levels, of which 71-94% stabilized on the reef. In total 55-57% of the tetrapods that were originally seeded to the reef still harbored ≥1 recruit (SU performance). The results of this initial study indicate seeding SUs without the need for transplantation offers great potential to increase the scale of reef restoration efforts. Case studies carried out in Mexico, Guam and Singapore further highlight possibilities and limitations of this new concept.

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FRESHWATER LENS DYNAMICS UNDER THE MAIN ISLAND OF AILUK ATOLL, NORTHERN MARSHALL ISLANDS (Abstract ID: 28100 | Poster ID: 395)

Rising sea levels and drought threaten atoll settlements, as cisterns dry and wells become brackish, and in our study location, Ailuk Atoll in the northern Marshall Islands, such an event necessitated the emergency deployment of aid reverse osmosis (RO) treatment units. Drought events are likely to continue; records on nearby Kwajalein Atoll indicate an annual decline of 2.5 mm pa since 1954. Whilst the synergies between precipitation, groundwater lenses and saltwater inundation have been modelled, measurements are lacking. Here we provide a summary of groundwater lens dynamics on remote Ailuk Atoll in the northern Marshall Islands, combining ground water levels, sea water influences, precipitation, and coral reef status in a groundwater dynamic model. We used wells in different locations around the main island to monitor tidal fluctuations and the quality of groundwater. We surveyed the ground elevation, coastline, wave attenuation on different exposures, and reviewed historical records. The lens recharges 0.7 ML/mm rain - less seaward losses and evapotranspiration. Most household wells were too brackish to serve potable needs. Tidal efficiency of wells and taro pits was found range from 8% to 16%. The strongest correlation was found at the Dispensary set among a grove of luxuriant breadfruit trees, which coincidentally also had the least lag from the lagoon and among the least brackish. Modelling accounts for the lens as a leaky reservoir so that it can be managed to support a sustainable island ecosystem - perhaps with a sand dredge to maintain shore elevation.

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NO-FISHING RESERVES PROTECT CORAL ASSEMBLAGES (Abstract ID: 27811 | Poster ID: 638)

Nature reserves are used globally as a management tool for protecting biodiversity both on land and in the sea. In 1976, Australia established the Great Barrier Reef (GBR) Marine Park, then by far the largest marine protected area in the world. In 2004, 33% of the Park was designated as no-fishing reserves, creating a globally significant network of highly protected reserves that stretches along the 2000 km length of the Reef. As expected, the number and sizes of targeted fishes are consistently higher inside well-protected no-fishing reserves. However, a recent meta-analysis of coral cover throughout the tropics found that coral abundance was stable over a one-year period within marine parks, whereas cover on unprotected reefs declined slightly by 0.3% in the Caribbean and 0.4% in the Indo-Pacific. Therefore, it remains unclear if marine reserves also afford protection to corals, the principal architects of tropical reefs. We quantified coral cover and composition at different life history stages along the length of the GBR. We found that corals are substantially more abundant inside no-fishing reserves. Furthermore, the species composition of coral assemblages also changes as cover increases, indicating that fishing can generate important functional differences between reefs located within reserves and those where fishing is present. The abundances of newly settled and juvenile corals do not differ between reserves and fished reefs, suggesting that protection by no-fishing reserves can be beneficial to adult corals.

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ANNOTATING AND ANALYZING LANDSCAPE-SCALE 3D MAPS OF BENTHIC HABITATS IN CORAL-REEF ECOSYSTEMS (Abstract ID: 30124)

Systematic underwater photography can be used to assemble a detailed digital record of a benthic landscape's visual appearance, topography and geometric structure. Photogrammetric and computer vision techniques enable the reconstruction of massive 3D pointclouds---on the order of 500 million to 1 billion points for a 100 m^2 region---offering a dense digital representation of the landscape under study. We describe the development of an efficient visual workflow for interactively inspecting and annotating such massive datasets, with the aim of increasing their utility for performing ecological analyses. In particular, we describe a scriptable software framework allowing taxonomic annotation to be performed by virtually 'painting' the desired classifications onto the visualized pointclouds, differentiating individual colonies. As an aid to classification, the system can drape the most appropriate raw photograph locally onto the pointcloud (or display it separately)---making the entirety of the collected data efficiently accessible. Further quantitative and qualitative analyses can be done both programmatically---by writing and executing a script traversing the annotated dataset---and interactively, with the use of custom script-defined measurement tools and 'brushes.' For example, the spatial distribution of colonies of a given morphology can be assessed, or the points constituting one or more colonies can be exported (and optionally meshed and filtered) for further study. We evaluate the results of these experiments and discuss our planned next steps.

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CAPACITY BUILDING IN THE CORAL TRIANGLE REGION: G2G EFFORTS (Abstract ID: 27907)

Since 2009, The Coral Triangle Initiative has proved a unique opportunity to provide government to government support for capacity building around ocean and coastal resource management - from Marine Protected Area Management, Ecosystem Approach to Fisheries Management, and Illegal, Unreported, and Unregulated Fisheries. This initiative has included the governments of the six CTI countries (Indonesia, Malaysia, Philippines, Papau New Guinea, Solomon Islands, and Timor-Leste), several USAID missions, NOAA, and several international and local NGOs. The main goal of this initiative was to build capacity and partnership towards better ocean governance. We will provide an overview of our project with USAID-Philippines and the government of Philippines with short presentations from the Bureau of Fisheries and Aquatic Resources and the Biodiversity Management Bureau.

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OUR PROJECT IN HAWAI'I'S INTERTIDAL (OPIHI): CITIZEN SCIENCE IN AN ACCESSIBLE MARINE ENVIRONMENT (Abstract ID: 30086)

Our Project In Hawai'i's Intertidal (OPIHI) is a citizen science program for middle- and high-school teachers and students to survey rocky intertidal areas in Hawai'i—a place-based, problem-based approach to learning through inquiry. The intertidal is vulnerable to threats such as overharvesting, species invasions, and climate change effects. Howev-

er, long-term monitoring is difficult to implement as seasonal wave activity, a small low tide window, and limited tidal range mean the Hawaiian intertidal is often underwater or inaccessible. Fortunately, the accessibility that makes the intertidal susceptible to human impacts also makes it ideal for citizen-science research. The intertidal provides a safe environment to engage students in marine science, an environment that might otherwise be overlooked by educators due to student swimming restrictions. Teachers are prepared to lead their students to collect rigorous monitoring data through the OPIHI professional development program. OPIHI has both scientific and educational goals: (a) to improve the content and scientific process knowledge of teachers and students, and (b) investigate if and how the Hawaiian intertidal community has changed since the last OPIHI systematic surveys were conducted 10 years ago. This paper will share preliminary educational and scientific results from our statewide spring 2017 OPIHI teachers and their students. We will also share best practices and lessons learned on conducting citizen science research with students in species-rich environments—including data validation and training techniques.

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LINKING PLOT TO REEF SCALES – HOW REEF SCIENCE AND MANAGEMENT BENEFITS FROM OPEN DATA, MODELS AND KNOWLEDGE (Abstract ID: 28106 | Poster ID: 544)

Significant changes in how we conduct coral reef science and management over the past five years have altered how we collect and share data, as well as how we build, evaluate and share methods and knowledge. This paper examines how changes in data collection, analysis, modelling and publication are affecting coral reef science and management. A critical assessment is provided of both the use of science in management and the increasing role of public involvement through community engagement and citizen science. A fundamental conceptual model linking different scales of coral reef structures and processes, from polyps to reef scales, is initially presented to define the scope of data and knowledge required for addressing current coral reef science and management objectives. Within this framework, open data publication and data re-use represent a key factor for a more open, reproducible and transparent set of scientific activities. Additionally, open collaboration provides the basis for developing regional to global scale models and assessments, as well as creating code repositories for the implementation, validation, and modification of methods in other study areas. Specific examples are shown from different large-scale, long-term, regional and global data sets, which demonstrate the advantages that open data and open collaboration provide for achieving expanded science capabilities. This collaborative, multi- and inter-disciplinary approach is essential for addressing the many regional and global challenges faced by the coral reef science community.

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FROM JAPAN TO THE NORTHERN TIP OF THE RED SEA: A LONG, NON-STOP JOURNEY FOR THE MESOPHOTIC SCLERACTINIAN SPECIES*LEPTOSERIS AMITORIENSIS* ? (Abstract ID: 28564)

*Leptoseris amitoriensis* Veron, 1990 was described from Amitori Bay, Iriomote, in the Ryukyu Archipelago, Japan. In Amitori Bay, it is a rather abundant, typically mesophotic species, found around and below 50 m depth, co-occurring with other *Leptoseris* species with a wider depth range, such as *L. gardineri*, *L. papyracea* and possibly other *Leptoseris* species. More recently the species was collected, also at mesophotic depths in several stations at Eilat and Aqaba, the northernmost tip of the Red Sea, where it can be equally abundant, forming large thickets of typically foliose colonies. Specific identity of the specimens from both locations has been confirmed by examination of colony gross morphology, both live *in situ* and from skeletal material, detailed stereomicroscopic examinations, Scanning Electron Microscopy imaging and genetic analyses. Comparisons of skeletal morphologies indicate that specimens from both localities are conspecific. This conclusion is also supported by the genetic data despite the complex situation of molecular evolution in *Leptoseris* and corals in general. The presence of the species in such widely separated areas in the Indo-Pacific, is indeed a remarkable case of complete dissociation of geographic distribution likely to be unique in the scleractinian world. We propose that such a distribution in the mesophotic environment may indicate either the presence of relict populations or a more widespread distribution in the hitherto little explored or unexplored deeper reef communities.

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THE APPLICATION OF SOCIOECONOMIC MONITORING (SOCMON) METHODOLOGY IN ASSESSING BETWEEN TWO TIME PERIODS BINDUYAN MARINE PROTECTED AREA IN PALAWAN, PHILIPPINES (Abstract ID: 29489)

Integration of Socioeconomic Monitoring (SocMon) at conservation sites can serve to involve local communities in resource management, provide adaptive management strategies to reflect the local needs, and facilitate understanding of the importance of marine and coastal resources. In 2007, the SocMon methodology was used to assess the status of Binduyan Marine Protected Area (MPA) in Puerto Princesa City, Palawan Province, Philippines. The same methodology was used in 2016 (nine years later) to assess the status of the same MPA. In addition to using the same set of selected SocMon indicators/variables, this study also involved other features that included an enrichment of data gathering methods including the following: (1) additional data on coastal and marine goods/activities using focused group discussion (FGD) method; (2) household level climate change variables, including vulnerability, using household interview (HHI); and (3) community-level climate change indicators/variables using FGD. The SocMon methodology was found useful in coming up with a comparative perspective between two time periods. This project has become an avenue to propagate the use of SocMon among academics, researchers, policy makers and coastal managers thereby enhancing coral reef conservation and coastal resources management. SocMon has likewise become a capacity building tool by convening and training new researchers, managers and key stakeholders in generating relevant socioeconomic information.

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EFFECTS OF CORAL DISEASE ON EXOSYMBIOTIC INVERTEBRATE ASSEMBLAGE (Abstract ID: 30160 | Poster ID: 614)

Coral diseases have persisted in our global oceans altering coral reef ecology. As environmental conditions continue to alter ocean processes, coral colonies will be left vulnerable to disease occurrences (Bruno 2007, Galloway 2009, Abey et al. 2010). Common coral diseases such as coral bleaching, algal over growth, Trematodiasis, and growth anomalies cause a variety of afflictions that increases coral mortality (Bruno 2007, Work 2008, Becker 2013). Scleractinian coral species are primary reef builders that play major roles within coral reef systems. Predominant corals impacted by disease are species from the montiporid, pocilloporid, and poritid coral families (Domart-Coulon 2006, Work 2008, Burns 2011). Because of different morphological features and physiological processes these coral species are host to many invertebrate exosymbionts that will either seek refuge within or on the coral or feed on the coral itself (Bailey-Brock 1976, Ritson-Williams 2003, Apprill 2007, Shima 2010). These relationships can be either specific or general depending on the coral host and the exosymbiont (Ritson-Williams 2003, LaJeunesse, 2004). The impact to these relationships from coral disease has been understudied with little understanding of the effect of disease on exosymbiont assemblage. This study aims to examine the invertebrate exosymbiont assemblage on diseased and healthy Porites colonies and create a field definition for growth anomalies (GA) on Porites species that will contribute to understanding the impact coral disease has at the community level to coral reef systems.

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MESOPHOTIC CORAL REEF FISH COMMUNITIES IN THE CENTER OF MARINE BIODIVERSITY (Abstract ID: 28858)

Philippines coral reefs are known for their extremely high biodiversity. However, most of the information available for the area comes exclusively from shallow reefs, with very few data published on Philippines' mesophotic coral ecosystems (MCEs, 30-150m depth). Here we describe the MCE fish community of three sites of the Verde Island Passage, Philippines, the center of the center of global marine biodiversity. Sampling was done using trimix (a breathing mix containing helium, nitrogen, and oxygen) closed-circuit rebreather diving. Data was obtained from 20 underwater visual censuses at depths between 45 and 105 meters. A total of 22 families and 87 species were recorded, with an average (SE) of 9.9 (0.9) species and 47 .7 (11.7) individuals per 40 m2. The richest families were Labridae (16 species), Serranidae (12), Pomacentridae (11), Pomacanthidae (8) and Chaetodontidae (6). Both richness and density of fishes decreased significantly with depth. Community composition also changed with depth: the most abundant fishes of the upper MCE zone (45-70m) were Chromis analis, Pseudanthias luzonensis, Pterocaesio pisang and Naso minor. Dominant fishes of the lower MCE zone (70-105m) were Paracaesio sordidus, Genicanthus melanospilus, Pseudanthias engelhardi and Genicanthus lamarck. Although some commercial species and sharks were recorded, signs of overfishing and habitat degradation were also observed, and in some sites the

bottom was covered in abandoned broken fishing lines. Since most people don't know these diverse ecosystems exist and they sit outside marine protected areas, research and an education campaign are necessary to better understand and protected them.

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ORIGIN AND MAINTENANCE OF REEF FISH BIODIVERSITY IN SEAMOUNTS AND OCEANIC ISLANDS OF THE SOUTH ATLANTIC (Abstract ID: 28714)

In the Southwestern Atlantic, twelve species are considered endemic to the seamounts and islands of the Vitória-Trindade Chain (VTC). Endemic species exclusive to the islands are suggested to have undergone allopatric speciation after sea level made the seamounts connecting continental and insular populations uninhabitable by shallow water species. These island endemic species are small and have limited dispersal ability. Most of them are genetically and morphologically very similar to their mainland sister species, suggesting recent divergence. Others endemics are wide spread along deeper (mesophotic) ecosystems of VTC seamounts and islands, and also show evidence of recent divergence. However, simple isolation cannot explain the origins of these species. In addition, two species endemic to the shallow waters of the islands and two from mesophotic habitats along the chain are much older than most species (i.e.: paleo-endemics or relict species). We hypothesize that VTC seamounts became a refugia for coral reef fauna during Pleistocene climatic variations, preserving these relict lineages, probably due to environmental stability. Therefore, VTC islands and seamounts seem to be acting as both cradle and museums for reef fish biodiversity.

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EQUIVALENCE OF MARINE DISPERSAL SCALES OVER EVOLUTIONARY AND ECOLOGICAL TIME (Abstract ID: 29005)

The scales over which offspring disperse is critical for understanding ecology and evolution in the ocean. At the moment, most estimates suggesting short-distance dispersal are based on direct ecological observations of dispersing individuals, while evolutionary estimates often suggest greater homogeneity among populations. Reconciling these two approaches and their seemingly competing perspectives on dispersal has been a major challenge. Here we show that evolutionary and ecological measurements of dispersal can agree, if carefully calculated and compared. In populations of the orange clownfish (*Amphiprion percula*), we found that evolutionary isolation by distance methods almost exactly matched an exhaustive set of direct larval dispersal observations in two separate time periods. Our results also suggest that carefully constructed evolutionary estimates may be more broadly relevant for understanding ecological dynamics than previously recognized.

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BACKGROUND RATES OF MORTALITY AND INJURY FOR COMMON CORAL TAXA ON AUSTRALIA'S GREAT BARRIER REEF (Abstract ID: 28685)

Studies on the population and community dynamics of scleractinian corals typically focus on catastrophic mortality associated with acute disturbances (e.g., coral bleaching and outbreaks of crown-of-thorn starfish), though corals are subject to high levels of background mortality and injuries caused by routine and chronic processes. This study quantified prevalence (proportion of colonies with injuries) and severity (areal extent of injuries on individual colonies) of background mortality and injuries for four common coral taxa (massive Porites, encrusting Montipora, Acropora hyacinthus and branching Pocillopora) on the Great Barrier Reef, Australia. Sampling was conducted over three consecutive years during which there were no major acute disturbances. A total of 2,276 adult colonies were surveyed across 27 sites, within nine reefs and three distinct latitudinal sectors. The prevalence of injuries was very high (>83%) across all four taxa, but highest for Porites (91%) and Montipora (85%). For these taxa (Montipora and Pocillopora) there was also significant temporal and spatial variation in prevalence of partial mortality. The severity of injuries ranged from 3% to more than 80% and varied among coral taxa, but was fairly constant spatially and temporally. Establishing background levels of injury and regeneration are important for understanding energy investment and life-history consequences for reef-building corals as well as for predicting susceptibility to, and capacity to recover from, acute disturbances.

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A DECISION SUPPORT FRAMEWORK TO PRIORITIZE CORAL REEFS FOR CONSERVATION IN THE U.S. VIRGIN ISLANDS (Abstract ID: 29402)

The coral reef ecosystems of the U.S. Virgin Islands are some of the most intensively surveyed and threatened tropical ecosystems on earth. These coral reefs vary widely in terms of biophysical structure, seascape context, socio-economic value and exposure to threats presenting a complex challenge for resilience-based management. How should managers prioritize actions to maximize conservation outcomes? To meet multiple conservation objectives, a novel map-based decision support tool was designed to synthesize large amounts of data to help managers identify and rank coral reefs according to quality and threats. The framework integrates local expert knowledge from SCUBA divers, scientific field data and spatial models on biophysical features, ecosystem services, stressors and resilience to characterize and rank priority coral reefs. The framework will support risk assessments of coastal development, management of protected areas, optimization of monitoring designs and broader marine spatial planning.

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SIMPLE, FAST AND REPEATABLE SURVEYS FOR UNDERWATER VISUAL 3D BENTHIC MAPPING (Abstract ID: 29102)

State of the art visual 3D reconstruction techniques provide rich structural information from underwater imagery. However, systematically covering areas much larger than the footprint of a single image is challenging underwater. Properly instrumented robots perform this task by precisely navigating a desired survey path. Unfortunately, access to suitable robotic systems is limited and requires specialised operators, which curtails the use and impact of these techniques. While humans can carry a similarly instrumented imaging package, they cannot navigate so as to consistently maintain image overlap over large extents. We present a simple method to quickly generate repeatable, high resolution and large extent (~100m2) surveys with one swimmer and one support person (~15 min). The amount of image overlap is a design parameter, yielding surveys that can be used in an automated processing pipeline to generate georeferenced 3D reconstructions, orthographic 2D mosaics and structural complexity indices. Individual images or mosaics can also be labeled for benthic cover estimates. We describe the method and present results from surveys conducted at reefs around Lizard Island in the Great Barrier Reef, as part of an ongoing cyclone recovery monitoring project. As of 2016, 21 sites have been visited 4 times, every ~6 months. We characterise the quality of data products and repeatability of the technique. Its speed and reliability make it suitable for large-scale benthic monitoring and research programs that aim to capture structural complexity and benthic community dynamics.

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CHARACTERIZING AN IMPROBABLE REEF AT VARADERO, CARTAGENA BAY, COLOMBIA (Abstract ID: 29888 | Poster ID: 300)

In 2013, Colombian scientists discovered Varadero reef in the least expected place. The reef is located off one of the entrances of Cartagena Bay (Colombia), a highly polluted Bay that receives industrial and sewage waste, as well as high sediment and freshwater loads from an outlet of Magdalena River. The latter is the main cause of the loss of all reefs within the Bay and the high reef degradation at nearby Rosario Archipelago.

Varadero reef was overlooked as the high turbidity of its overlying waters led to the assumption that no corals would develop. After a quick initial characterization, Varadero reef was shown as one of the healthiest reefs in Colombian Caribbean waters (up to 80% live coral cover). To understand how and why a highly developed reef is thriving under such unusual conditions, in 2015 data were collected to have a more complete description of the reef in terms of extension, community composition and diversity, coral health and water quality. Varadero reef extends over 1740 m and continues towards Baru island. Although reef structure starts at 30 m, high coral cover is between 2 and 12 m depth. A total of 38 coral species occur there, with Orbicella spp. as the dominant genus. Average live coral cover was 47% and disease prevalence was less than 0,4%. Varadero reef seems to be healthier than nearby reefs, despite the poor quality of its overlying waters. Future research includes studies on the coral holobiont and its responses to environmental drivers and physiological observations to assess algal performance and coral calcification rates.

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CORAL REEF ASSOCIATED CRYTPOFAUNA DIVERSITY PATTERNS ALONG A NATURAL PH GRADIENT (Abstract ID: 28856)

Naturally occurring high CO2 zones on coral reefs provide us with the opportunity to study whole community patterns of biodiversity influenced by both the direct and indirect effects of low pH. We investigated the cryptofauna diversity at two localities in the Milne Bay Province, Papua New Guinea, where CO2 vents provide naturally low pH conditions. We deployed standardized 3-dimensional samplers (ARMS) on the reef at 3 m depth at three pH regimes (regular 8.0, medium 7.8-7.9 and low 7.6-7.8). After 2 years, we retrieved the structures and extracted all living organisms. The larger motile invertebrates (>2mm) were individually barcoded using the standard cytochrome oxidase subunit I fragment (COI). The smaller motile organisms (500 - 2000 µm) and the sessile organisms were bulk collected and metabarcoded using high-throughput sequencing of a shorter COI fragment. Diversity patterns were most different for the >2mm invertebrate fraction with a reduction of 56% in diversity and 60% in abundance at the lowest pH. Rarefaction curves showed that ACE diversity estimator reached a plateau at low pH, whereas curves continued to rise in control pH. The differences were not as pronounced for the bulk fractions with reductions in diversity of 24% and 21% for the motile and sessile fractions. The ARMS community composition at higher taxonomic levels was similar in all pH conditions. The resulting data allow us to determine how future changes in pH could affect coral reef diversity while providing critical data for a region and fauna that are both highly diverse and poorly known.

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CONNECTING SCIENCE AND PEOPLE TO IMPROVE LOCAL FISHERIES MANAGEMENT WITH GLENN (Abstract ID: 29627)

Understanding the complex life cycle of coral reef fish is of critical importance if we are to succeed in improving fisheries management. But science alone cannot solve management problems. In the Pacific, local communities have been managing their marine resources for millennia, but with today's changing world and dwindling resources, these communities are facing overfishing. To ensure the persistence of these island communities and cultures through time, science and local community management must come together to find solutions. Glenn's research was motivated by this concept, and his global proposal for the CNRS build a research program designed to improve marine conservation planning and biodiversity protection by synthesizing and incorporating connectivity data. Glenn himself was in fact a connector, as he used to say, with a goal of connecting the best colleagues to (1) increase understanding of ecological connectivity among coral reefs; (2) evaluate MPA theory and guidelines based on analyses of new connectivity data; and (3) revise or develop new tools to implement recommendations stemming from current projects. Glenn was a scientist and someone who cared deeply for people and nature and was driven to make important research outcomes relevant and accessible for decision to local communities, governments and NGO partners. This was his passion… and now his legacy.

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NON-RANDOM VARIABILITY IN FUNCTIONAL COMPOSITION OF CORAL REEF FISH COMMUNITIES ALONG AN ENVIRONMENTAL GRADIENT (Abstract ID: 28047 | Poster ID: 504)

Changes in the coral reef complex can affect predator-prey relationships, resource availability and niche utilisation in the associated fish community, which may be reflected in decreased stability of the functional traits present in a community. This is because particular traits may be favoured by a changing environment while other traits can be selected against where degradation can relax the association between fishes and benthic habitat. We characterised six important ecological traits for fish species occurring at seven sites across a coral reef archipelago in Indonesia, where reefs have been exposed to eutrophication for decades. Two functional diversity indices were related to important environmental factors (live coral cover, rugosity and distance from shore) examining both the change in mean, as well as temporal and spatial variability, to assess whether fish-habitat association became relaxed along with habitat degradation. Increases in live coral cover and rugosity were associated with decreases in the variability of functional diversity and with community-level changes in the abundance of several traits. A decrease in coral increased variability of RaoQ while rugosity and distance both inversely affected variability of FRic; however averages of these indices did not reveal patterns. These results suggest that increased degradation of coral reefs is associated with increased variability in fish community functional composition resulting from impacts on specific traits, thereby affecting the functional response of these communities to increasing perturbations.

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RESPONSES OF THE CORAL HOLOBIONT TO LABILE DISSOLVED ORGANIC CARBON SHED LIGHT ON THE ROLE OF DINITROGEN FIXATION IN BLEACHING (Abstract ID: 27922)

The temperature-induced disruption of the coral-algae symbiosis (coral bleaching) has caused a global coral reef decline. Still, the understanding of mechanisms underlying bleaching remains incomplete. Both elevated temperatures and labile dissolved organic carbon (DOC) not only induce bleaching, but also stimulate coral-associated dinitrogen (N2) fixation actvity. Thus, increased N2 fixation may mediate symbiotic breakdown by shifting Symbiodinium from nitrogen (N) limitation to phosphorus (P) starvation. To test this assertion, we selectively stimulated coral N2 fixation activity ex situ via daily doses of labile DOC over 28 days and measured individual responses of the main holobiont compartments of Pocillopora verrucosa. Corals exposed to high DOC conditions rapidly exhibited significantly increased N2 fixation rates and abundance of N2 fixing bacteria, and a depletion in Symbiodinium stable N. Together with an increase in the N:P ratio in algae and coral tissue, this confirms the rapid uptake of fixed N by algal symbionts. Concomitantly, we observed symbiotic breakdown resulting in bleaching, reflected in loss of symbiotic algae, and drop in photosynthetic yield and rates. Our data suggest the breakdown was caused by shifting algae to P starvation due to elevated fixed N availability. This mechanism appears independent of thermal stress. In conclusion, increased N2 fixation may mediate coral bleaching by alleviating Symbiodinium from N limitation. Our findings imply that improved water quality may mitigate the effects of anthropogenically-driven environmental change.

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EVIDENCE OF ADAPTATION IN A CORAL-ALGAL SYMBIOSIS AT MESOPHOTIC DEPTHS IN THE NORTHWEST GULF OF MEXICO (Abstract ID: 28846 | Poster ID: 331)

Many coral species common in shallow habitats also live in the mesophotic zone (30-150 m). Similar to shallow corals, many mesophotic corals maintain important symbioses with photosynthetic microalgae in the genus *Symbiodinium*. Despite the importance of the coral-algal symbiosis in corals' ability to thrive in multiple dynamic environments, few studies have focused on symbionts associated with mesophotic corals. This study compares the algal symbiont assemblages in *Montastraea cavernosa* found at shallow (20-25 m) and mesophotic (45-50 m) sites at the East and West banks of Flower Garden Banks (FGB) National Marine Sanctuary. Symbiont densities per unit area of coral tissue are significantly higher in mesophotic corals at FGB. Additionally, while chlorophyll concentrations are similar between depths, the overall chlorophyll concentrations per unit area of coral tissue are significantly higher in mesophotic corals. These results suggest that increased symbiont densities may be a method of adaptation for zooxanthellate corals in mesophotic reef environments. Symbiont densities and chlorophyll concentrations did not differ between the East and West banks. Next generation sequencing of the ITS2 gene provides a comprehensive assessment of symbiont community structure, including uniformly stable assemblages in *M. cavernosa* at the shallow sites. This study and ad-

ditional comparisons between shallow and mesophotic reefs are designed to help inform management strategies for FGB and similar coral reef communities.

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SHIPWRECKS, PHASE SHIFTS AND REEF RESTORATION: SCIENCE AND MANAGEMENT OF THE PALMYRA UNIT OF THE PACIFIC REMOTE ISLANDS MARINE NATIONAL MONUMENT (Abstract ID: 29616 | Poster ID: 626)

Management of remote coral reefs is a challenge, and the removal of a shipwreck 1600 km away from civilization is a daunting task. Palmyra Atoll is a unit of the Pacific Remote Islands Marine National Monument. The atoll is managed by the US Fish and Wildlife Service (FWS) and The Nature Conservancy, who administer a research station for the Palmyra Atoll Research Consortium (PARC). The grounding of a fishing vessel at Palmyra subsequently caused a phase shift from a healthy coral reef, to a monotypic stand of an invasive species. Systematic surveys and monitoring of Palmyra's reefs by PARC researchers' discovered corallimorph smothering the reef around the wreck, revealing the phase shift to be associated with the degrading wreck. Continued monitoring documented the spread of the corallimorph over 3 km of pristine coral reef. In the fall of 2013 the FWS, with the help of marine salvors, removed the wreck. Data collected by researchers were used to document both the spread of the corallimorph, indicating an immediate problem, and helped guide the removal process, leading to best management practices for removal and restoration without further damaging the reef ecosystem. Novel approaches were used to accomplish and monitor this difficult task. The wreck removal was the first step in a larger coral reef restoration project. Managers and partner scientists continue to monitor the corallimorph, efficacy of wreck removal, and explore options for larger-scale corallimorph treatment and habitat restoration. Information learned aids in the management of the Monument, and informs coral reef management throughout the Pacific.

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THE CORAL MICROBIOME ACROSS SPECIES, SPACE AND TIME (Abstract ID: 29365)

Coral-associated bacteria are increasingly recognized as indispensable contributors to coral physiology and health, yet we know very little about their basic ecology. Here, we employ high-throughput 16S rRNA gene sequencing to examine host, environmental and temporal influences on the microbiome of 35 coral taxa from three locations across Australia (Lizard Island, Northern Great Barrier Reef; Lord Howe Island, the world's most southern coral reef; and Ningaloo Reef, Indian Ocean). We also explore patterns in microbiome structure between seasons, through repeated sampling at Lizard Island, and across anatomic locations, by partitioning coral sample into mucus, tissue and skeleton compartments. This study characterizes the bacterial composition of 687 unique coral samples and 59 environmental samples (i.e. seawater and sediment) to assess: 1) the 'core' microbiome within and among coral taxa, 2) microbiome partitioning across micro-scale habitats within the coral host and 3) the influence of local environmental conditions on bacterial community structure. Establishing patterns in coral-associated microbiomes and determining the environmental factors underlying them is vital to understanding coral symbiont community assembly, and ultimately, the role of coral-associated microbes in host physiology and health.
http://www.FJPollock.com

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TOWED-DIVER SURVEYS OF THE 2015 CORAL BLEACHING EVENT IN HAWAII: AN EFFICIENT METHOD FOR BROADSCALE ASSESSMENT OF BLEACHING IMPACTS (Abstract ID: 28991)

The 2015 global coral bleaching event brought widespread impacts to Hawaii. Our team deployed on a 2-week research cruise in November 2015 to observe the spatial extent and severity of bleaching impacts in the main Hawaiian Islands using towed-diver survey methods. Survey tracks for the entire mission covered approximately 80 km of 15 m wide transects in coastal Maui, Lanai, Hawaii, and Oahu Islands at depths ranging from 2 to 10 m. A team of two towed divers collected visual estimates of percentage of live coral that was pale and bleached. Photographic data were collected using a downward-facing DSLR camera with strobes that captured a benthic image every 15 seconds. Conductivity, temperature, depth, chlorophyll-a, turbidity, and dissolved oxygen were collected continuously along each survey track using a suite of sensors mounted to the towboards. Preliminary analyses of field observations show significant bleaching affects at all islands. The most severe impacts were seen at Hawaii Island, where observers estimated 49% of live coral was affected by the event. We will present a correlative analysis of observer data with 1) total local degree heating weeks, 2) terrigenous input (sedimentation, development history, land use), and 3) the observed oceanographic parameters. Towed-diver surveys offer reef managers an efficient option for broad-scale characterization of extent, intensity, differential taxonomic response, and oceanographic correlates of coral bleaching.

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MOVINGTOWARDSANECOSYSTEMAPPROACHTO FISHERIES MANAGEMENTIN THE CORALTRIANGLEREGION (Abstract ID: 27924)

Applying an EAFM is considered the preferred option and best practice under the CTI-CFF for the long- term sustainability of fisheries and the ecosystem services provided to society (e.g., food security, livelihoods, economic security, coastal protection, human health and well-being). This paper presents progress of the six CTI countries toward implementation of an EAFM. The results of a country analysis of the existing institutional, policy and legal frameworks in terms of the ability of each country to align with EAFM principles is presented. Challenges to effective implementation of an EAFM in the Coral Triangle region are discussed and recommendations to overcome some of the key challenges are provided.

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MAPPING EFFECTS OF 3D HABITAT STRUCTURAL COMPLEXITY AND ORIGIN ON FISH ASSEMBLAGES (Abstract ID: 28098 | Poster ID: 237)

Habitat structural complexity is a key driver of local biotic assemblages. Modifications to marine habitat (both intentional and coincidental) present an opportunity to explore how elements of 3D complexity influence fish and sessile assemblages. To capture complexity at fish-relevant spatial extents and resolutions, a novel mapping tool using affordable and widely accessible off-the-shelf tools was developed and trialled. Target spatial extents of 500 – 1000 m2 were achieved with cm resolution and only 4% coefficient of variation. Paired with Underwater Visual Census data these maps allow exploration of the relationship between local assemblages and complexity at 100, 250 and 600 m2 spatial extents. Abundance and diversity increased with 3D complexity of habitat. Additionally, fish assemblages were significantly different at anthropogenic habitats (break walls) than at natural reefs. Interestingly, this trend was driven largely by pelagic species such as T. Novaezealandiae and highly habitat-attached species such as Pempheridiidae. These findings suggest that modifying structural complexity of anthropogenic structures could significantly influence local fish biodiversity.

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SPECIES DIVERSITY TRENDS OF STONY CORALS IN THE FLORIDA KEYS NATIONAL MARINE SANCTUARY, 1996-2010 (Abstract ID: 28709)

Coral biodiversity is critical to maintaining reef survival and function. We assessed the changes in coral community diversity to determine spatial and taxonomic patterns of change. Annual species counts were conducted at 34 fixed sites throughout the FKNMS over a 15-year period from 1996 - 2010. Keys-wide, average species richness declined at rate of -0.21 species per year. Species richness at deep sites along the offshore reef tract decreased most severely between 1996 and 2006, at a rate of -0.51 species per year, but leveled off after 2007. Shallow sites on the offshore reef tract had variable richness in the early years of the survey, but decreased at an average rate of -0.15 species per year since 1999. Mid-channel patch reef stations lost an average of -0.16 species per year throughout the survey period. Species lost from the highest number of sites included *Mycetophyllia ferox* (-35%), *Acropora cervicornis* (-32%), *Mycetophyllia lamarckiana* (-29%), and *Favia fragum* (-21%). Our data show a uniform, almost monotonic, decline in species. Multiple regression models reveal that spatial factors (such as shallow-offshore, deep-offshore, and patch reefs) and nutrient concentrations (both N and P) were the

most important parameters influencing species decline rates. These data argue against the influence of climatic extremes, such as hurricanes and bleaching events, and for the importance of chronic stressors, such as water quality, as major controllers of species number. Current (2016) El Nino conditions will test this hypothesis.

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LONG-TERM DYNAMICS OF A HIGH-LATITUDE CORAL COMMUNITY AT SODWANA BAY, SOUTH AFRICA (Abstract ID: 29347)

Dynamics in percentage cover, mortality and recruitment success of a high-latitude coral assemblage in South Africa were studied over 20 years with the rationale of detecting the effects of climate change. Coral communities at this locality are the southernmost on the African continent, non-accretive, attain high biodiversity and are dominated by soft corals. Long-term monitoring within fixed transects on representative reef was initiated in 1993, and has entailed annual photo-quadrat surveys and hourly temperature logging. Although sea temperatures rose by 0.15°C p.a. at the site up to 2000, they have subsequently been decreasing, and the overall trend based on monthly means since monitoring commenced has been a significant decrease of 0.03°C p.a. ($p = 0.0013$). Minor bleaching was encountered during the 1998 El Niño Southern Oscillation event. A significant decreasing trend in soft coral cover has been evident throughout the monitoring period, attributable to decreases in Sinularia and Lobophytum spp. cover ($p < 0.005$). Contrastingly, hard coral cover gradually and significantly increased ($p = 0.0048$) up to 2005, this being largely attributable to increases in cover by Acropora spp. ($p = 0.0089$). Recruitment success and mortality for both soft and hard corals has displayed high inter-annual variability with increasing but non-significant trends in the last five years. The reduction in soft coral cover has been more consistent and greater than that of hard corals but it is difficult at this stage to attribute this to changes in acidification-linked accretion or temperature.

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INCORPORATING CATASTROPHES AND PROBABILITY OF SUCCESS IN SPATIAL PLANNING OF MARINE CONSERVATION ACTIONS (Abstract ID: 28434)

Coral reef spatial planning focuses on representing a range of conservation features, usually habitats and species, and creating well-connected management area networks, while minimising impacts on human socio-economic systems. One area of conservation planning that is often ignored, or considered in a confused fashion, is risk and uncertainty. There is always uncertainty about data, there are different risks to different sites, plus there are risks conservation actions will fail (via catastrophes or poor implementation) . In this talk we will discuss a range of situations where threats, uncertainty and catastrophes affect the coral reef system of interest. First we note there are three kinds of threat – those that are stopped by marine reserves, those that are partially mitigated and those that are not mitigated and may be catastrophic (e.g. tropical storms). In the first situation, high threats lead to high benefits of actions, while in the third situation, high threats usually mean that we will avoid those sites for conservation action. Second, uncertainty in the ecological effect of actions and their socio-economic feasibility is clearly pivotal to planning, and can be quantified with probabilities (all of which are uncertain). In the spatial planning software, Marxan, we use probability theory to determine priorities for coral reef conservation that integrate threat and feasibility with issues of cost, connectivity and representation.
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EXTENSIVE LINEAGE DIVERSITY AND CRYPTIC SPECIES IN AGLAOPHENIIDAE (HYDROZOA) SPECIES REVEALED BY MOLECULAR SPECIES DELIMITATION METHODS AND POPULATION GENETICS (Abstract ID: 29309)

A comprehensive inventory of global biodiversity would be greatly improved by automating methods of species delimitation. The ABGD method, the PTP algorithm and the GMYC model, using single locus data, were proposed as means of increasing the rate of biodiversity description. We applied these methods to explore the cryptic diversity of Aglaopheniidae, a hydrozoan family widely distributed in the Indo-Pacific region. For two species of this family, Lytocarpia brevirostris and Macrorhynchia phoenicea, we compared the outputs to several clustering analyses based on microsatellite data and to nuclear genes phylogenies. Our analyses revealed widespread cryptic diversity in this family, various species presenting several independent evolutionary lineages, and supported hypothesized cases of synonymy. Comparisons of results between species delimitation methods and microsatellite data were congruent for Lytocarpia brevirostris, revealing the existence two cryptic species. For Macrorhynchia phoenicea, results were inconsistent but all analyses confirmed the divergence of two evolutionary lineages in the South-West Indian Ocean that could not be distinguished using standard morphological characters. Our study suggests that the diversity of Aglaopheniidae might be extremely high, likely due to low dispersal capacities. Sequence-based species delimitation methods seem highly valuable to reveal cryptic diversity in hydrozoans; their application in an integrative framework will be very useful in describing the phyletic diversity these organisms.

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INVOLVING TRADITIONAL FISHERMEN IN MPA MANAGEMENT : TOWARDS A WIN-WIN SITUATION IN REUNION (Abstract ID: 29478 | Poster ID: 605)

The success of conservation initiatives is often linked to trade-offs between the stakeholders' personal interests, the protection of the natural ecosystem and the management initiatives. Coral reefs in Reunion are limited to the west coast and strongly exploited by a variety of users, that includes the traditional fishermen. These fishermen fish using traditional fishing gears but do not depend anymore on their catch for their livelihood thanks to the government aids. In January 2015, they started arguing with the management team about possible changes of the MPA regulation policy, especially regarding the move of their fishing zones and the increase in fishing duration. The MPA team took this opportunity to propose a "win-win" contract, which aimed in reinforcing the MPA acceptation within the fishermen. It agreed for some changes in the location of the fishing zones if the fishermen accepted to strictly follow the regulations and participate in the daily collection of fishery data using a logbook. Fisheries mediators were planned to be recruited to verify the fishermen engagement and maintain a strong link between the two stakeholders. Good progress was made and the new fishing zones were ready to be opened after one year. Nevertheless, the fishermen ended the discussion process at the last minute. This presentation will discuss on the success and limits of this challenging situation, which is a common problem in MPA management and can be used for further comparison.

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MACROPLANKTON, MICRONESIA, AND MESOSCALE MOVEMENT MODELS: QUANTIFYING LARVAL TRANSPORT PATHWAYS AROUND THE MARIANA ARCHIPELAGO (Abstract ID: 29891)

Many coral reef organisms have a larval development phase in pelagic environments. These larvae may return to their natal islands or be dispersed downstream in ocean currents. Understanding the strength and geographic patterns of larval connectivity is an important part of managing marine ecosystems through ecosystem based fisheries management, marine protected area network design, recovery strategies for endangered species, and promoting resilient reefs. Sufficient sources of larvae must be maintained to sustain future generations. In recent years, there have been calls for a better understanding of larval connectivity in the Mariana Archipelago, an ~800 km span of islands and submerged banks that includes the Commonwealth of the Northern Mariana Islands and Guam. To evaluate ocean currents as a mechanism of larval transport in this region and to compare larval connectivity patterns for several taxa, computer simulations were used to track cohorts of virtual larvae transported according to an ocean circulation model. Virtual larvae were spawned from 2004-2012 at each of 116 locations. Larval production was scaled to each island's area of potential reef ecosystem. Simulations incorporated several larval life history parameters, including pelagic larval duration, precompetency, mortality, and sensory capability. Cumulative connectivity over the 9 year period was summarized for the entire region. The role of each island in the archipelago as a larval source or destination was evaluated. For Saipan and Guam seasonal and inter-annual variation in larval supply was examined.

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EFFECTS OF TEMPERATURE AND PH ON GROWTH OF *OSTREOPSIS* CF.*SIAMENSIS* (Abstract ID: 29936 | Poster ID: 407)

The impact of global warming on high temperature and low pH of seawater lead to coral bleaching and benthic microalga bloom in coral reef area.*Ostreopsis* cf. *siamensis* is a benthic dinoflagellate that reported as one causative microalga for ciguatera fish toxin. In order to clarify the effects of temperature and pH on growth of *Ostreopsis* cf. *siamensis*, the experiments have been conducted on this species isolated from Chang Island. Three set of temperature at 27 (control), 30 and 33 C have been designed for the experiments. For each temperature level there were four experiments of pH 6, 7, 8 and 9. Sampling cells were enumerated every 2 days for 25 days. Cells cultured at 27 and 30 had the normal growth rate whereas the growth rate of cell at 33 C gradually decreased from the beginning and most cells died on day 15. At 27 and 30 C *Ostreopsis* cf. *siamensis* grew normally in all pH levels but very low growth rate with high mucus excretion and pale cell color have been found at pH 9. The highest specific growth rate of 0.56 was found in pH 6 at 27 C.

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## A DIFFERENT KIND OF OCEAN ACIDIFICATION AND ANOTHER REFUGIUM FOR PH-TOLERANT ORGANISMS (Abstract ID: 30053)

Many modern reefs grow on submerged portions of older limestones deposited by previous reef systems. Sub-surface cavities, formed by karstic erosion during lower Pleistocene sea levels, now channel meteoric groundwater offshore, where it often emerges as submarine springs in or near living reefs. As rainwater percolates through karstic sediments and limestones, dissolved carbon dioxide reacts with calcium carbonate; modifies pH, alkalinity, and carbonate saturation states; and leads to other changes in water chemistry. Off the coast of the Yucatan Peninsula, this groundwater mixes with seawater before discharging at permanent springs or "ojos" with water that is close to oceanic salinity but has low pH, elevated alkalinity, and variable nutrient content. Many ojos are surrounded by often stable and persistent pH and alkalinity gradients that are occupied by long-lived calcifying organisms. We describe assemblages of coralline algae and scleractinian corals living in a system of low pH springs near Puerto Morales, Mexico and summarize physical and chemical correlates. We hypothesize that individuals able to survive for decades in these gradients have genotypes (i.e., adaptation) or plastic phenotypes (i.e., acclimatization) likely to confer tolerance of low pH. While each spring may be too small for recruitment of planktonic larvae to their parental sites, multiple springs within a defined region ensure that some tolerant individuals are always present within the region, and they are likely to increase in abundance and distribution with increasing acidification of the oceans.

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## KEEP THE EYES ON THE REEF DURING HOT SEASON IN ARCHIPELAGIC NATION OF INDONESIA: A CASE OF CORAL BLEACHING NETWORK INDONESIA (Abstract ID: 29306)

To monitor bleaching event and how the reef is impacted, timing is really important. However, tracking bleaching development in vast-scattered reef nations such as Indonesia is really challenging. Reef Check Network Indonesia (RCNI) and partners worked together in creating a coral bleaching network to cope with 2009-2010 bleaching event. An alert, based on NOAA coral bleaching satellite data, was distributed regularly to the network during the hot season. This is followed by personal communication to certain members in bleaching alert areas. The network provided an in situ coral bleaching early warning. RCNI then distributed this information to its scientist members so they can determined whether or not a more thorough coral bleaching data was needed. By 2010, the network gathered the most comprehensive coral bleaching data in Indonesia despite that there was no resources dedicated to this effort. The success lays behind RCNI structured. Started in 1997, the network rapidly grows comprising ranges of reef stakeholders from individual to institution, from fisherman to scientists. By 2015 the network has covered all main islands in Indonesia, involving up to 2,500 volunteers. A headquarter coordinates the network and provides supports for both science capacity and organizational building. To minimize the costs, innovative coordination using various modes include social media. With the bleak prediction of future bleaching events, it is hoped that the RCNI can be strengthened and expanded by using a more high tech and simpler information sharing system, as well as a data base.
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## EMPTY NICHES AFTER EXTINCTIONS INCREASE POPULATION SIZES OF MODERN CORALS (Abstract ID: 28334)

Estimates of population size as a function of time can show how history has shaped the evolution of current species, provide accurate models to interpret contemporary genetic data, and generate a framework to implement successful conservation strategies. This information is relevant when paleontological evidence is rich and provides direct ecological evidence on what triggers variations in population size. We studied how variation in abiotic and biotic environments since the late Pliocene shaped historical changes in the population sizes of corals of the genus Orbicella, the major current reef builders in the Caribbean. Our results suggest populations of all three Orbicella species share patterns of population decline around 1-2 million years ago (Ma) coincident with the extinction of 80 % of Caribbean coral species. The change in population size is consistent for the three species despite their ecological difference. More recently, the two shallower specialists, O. faveolata and O. annularis expanded their population sizes by at least two fold. The growth of these two species coincides with the recent disappearance of their sister competitor species Orbicella nancyi (organ-pipe). Our study suggests that populations of modern Orbicella species are capable of rebounding from reductions in population size under suitable conditions.
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## OCEAN WARMING AND ACIDIFICATION SYNERGISTICALLY INCREASE CORAL MORTALITY (Abstract ID: 29374)

CO2-driven ocean warming (OW) and acidification (OA) has prompted urgent research to assess their potential effects on the marine environment, with strong emphasis on calcifying organisms. To correctly predict how these stressors will affect marine organisms, their synergistic effects must be assessed. Here we investigate the interactive effects of OW and OA on the mortality and growth of three Mediterranean coral species: the solitary zooxanthellate Balanophyllia europaea, the solitary non-zooxanthellate Leptopsammia pruvoti and the colonial non-zooxanthellate Astroides calycularis. Corals were transplanted, in different seasons, in proximity to a volcanic CO2 vent where water is naturally acidified to levels matching future IPCC scenarios. We show a strong synergistic adverse effect on mortality rates of the three species. Net calcification rates of the zooxanthellate species were not affected by reduced pH, while those of the two non-zooxanthellate species were negatively affected, indicating that different levels of resilience/resistance to OW and OA among species in symbiosis with photosynthetic algae or asymbiotic ones may be related to different modes of nutrition and/or biomineralization processes. Natural CO2-leaking marine sites can provide essential information on the combined effects of OA and OW on Mediterranean scleractinian corals, which may help understand to which extent different corals will be threatened by increasing atmospheric CO2 pollution.

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ACCLIMATION OF ADULT AND JUVENILE MESOPHOTIC *SERIATOPORA HYSTRIX* TO SHALLOW REEF HABITATS (Abstract ID: 29381)

Mesophotic coral ecosystems (MCEs), have often been suggested as a source to recolonize shallow reefs. Shallow reef recovery could occur through natural (i.e. larval recruitment) or artificial recolonization (i.e. man-made transplantation). However, the success of the mesophotic coral's contribution to shallow reef recovery depends on their ability to acclimate to shallow reef conditions. Here we examined the physiological capacity of adults and juveniles of the coral *Seriatopora hystrix* from an upper MCE (ca. 40 m depth) to acclimate to shallow reef conditions for 6 months. Both adult fragments and coral juveniles were transplanted to 3, 20, and 40 m depth reef habitats and monitored monthly. Most of the adult fragments at 3 m depth were lost due to a typhoon and were discarded from the analysis. High survival of adults was observed at 20 m and 40 m depth. All coral juveniles died when transplanted at 3 m depth, while at 20 m and 40 m depth they died by an average of 20.5% and 21% every month, respectively. This study revealed the capacity of mesophotic *Seriatopora hystrix* to acclimate to shallower environmental conditions. The mid-depth reef habitats (i.e. 20 m depth) might act as a stepping-stone for shallow reef recovery, with mesophotic corals avoiding mortality due to extreme environmental conditions in the shallow reefs but adapting to shallower conditions. The photophysiological and symbiont characteristics of the transplants and their role in the adaptation process will be discussed.

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VARIABLE REPRODUCTIVE TIMING AND FECUNDITY OF CROWN-OF-THORNS STARFISH (ACANTHASTER CF. PLANCI) IN THE NORTHERN GREAT BARRIER REEF, AUSTRALIA. (Abstract ID: 28479)

Understanding the initiation and spread of outbreaks of crown-of-thorns starfish (Acanthaster cf. planci) requires detailed knowledge of their reproductive behavior and output. While crown-of-thorns starfish are known to have exceptional reproductive potential, reported estimates of fecundity are based on limited sampling from just one location. We quantified fecundity for a wide range of individuals collected from the northern Great Barrier Reef, and showed that fecundity varies enormously with individual size and condition. This study also examined temporal changes in the reproductive condition of crown-of-thorns starfish collected from the same location every month for 2 years, revealing marked inter-annual differences in spawning behavior. In the first year of sampling, there was little evidence of any distinct spawning event and females had consistently large gonads throughout the summer period from November 2013 to April 2014. In 2014/15 however, there was a marked reduction in the size of gonads for females collected in late December versus early January, indicative of extensive spawning during this period. Variability in reproductive behaviour and output of crown-of-thorns starfish may account for spatial and temporal differences in the propensity for outbreaks to occur (e.g., in different geographic locations) and warrants much further investigation.

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BOOSTING CORAL REEF CONSERVATION THROUGH REGIONAL COLLABORATION: A LESSON LEARNED FROM REGIONAL CTI-CFF PARTNERSHIP (Abstract ID: 27851)

Coral reefs in Asia-Pacific region, particularly in the Coral Triangle area, is one of the most ecological, biological rich and huge regions on earth, which urgently need a commitment from people to conserve and protect from increasing potential natural and anthropogenic threats. Relying upon individual commitment from each country's to conserve is challenging as the coral reef ecosystem shows interconnectivity that clearly region-wide borderless system. At this point, regional initiative becomes fundamental. CTI-CFF is one of the regional initiatives engaging region-wide marine conservation. The initiative was established by head of states in May 2009 in Manado, of six-coral-triangle- countries: Indonesia, Malaysia, Papua New Guinea, Philippines, Timor Leste, and the Solomon Islands, which systematically wrap up individual and nation-wide commitment to region-wide conservation through a Regional Plan of Action. Regional collaboration through CTI-CFF boosts CT-marine protected areas in the view that it is not only for the sake of conservation, but also the MPA should be developed in the frame of prosperity of the people, sovereignty of the country, and sustainability of the resource use. In this presentation, challenges of managing regional activities would be discussed.

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THE EVOLUTIONARY CHALLENGE OF CLIMATE CHANGE: ADAPTIVE PROCESSES IN THE MEDITERRANEAN RED CORAL (Abstract ID: 27813 | Poster ID: 17)

The on-going climate change should have major impacts on the different components of biodiversity, from genes to ecosystems. Marine species, and especially corals, are already suffering from climate change, as shown by mortality events linked with thermal anomalies. These events highlighted a diversity of thermotolerance levels in the Mediterranean red coral (Corallium rubrum). The main objective of this work was to understand the origin of these differences and to search for local adaptation to thermal conditions in the red coral. This species is present in very contrasted ecological conditions which correspond to genetically differentiated populations. Moreover, colonies from different regions, but also from the same site at different depths , display thermotolerance differences. These differences can be linked to the individual history through acclimatization or to genetic adaptation at the population level. Two complementary approaches were developed to study these mechanisms: i. Transcriptomic (gene expression and polymorphism) basis of thermotolerance differences. ii. Genomic study of local adaptation. We looked for genetic-environment associations through the identification of outlier loci with particular patterns of genetic differentiation using RAD-sequencing (Restriction site Associated DNA sequencing). For this purpose we chose to compare populations from above the thermocline which deal with high thermal variations to populations from a more thermal stable zone below the thermocline. The obtained results are analyzed at the light of transcriptome polymorphism and plasticity.

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GALL CRABS, CORALS, AND WHITE PLAGUE; HOW ARE THEY ALL CONNECTED? (Abstract ID: 28340)

Cryptochiridae gall crabs are small crabs that reside on scleractinian corals, altering their morphology, physiology, and likely their microbiota. Despite their relative abundance, gall crabs are commonly overlooked in most scleractinian coral studies, and entirely absent in microbial studies. This aquarium-based study identified the Cryptochiridae gall crab as a potential disease vector for white plague-like lesions on the scleractinian corals*Diploria labyrinthiformis* and *Pseudodiploria strigosa*. 16S rRNA gene profiling demonstrated that the microbiota of white plague-like lesions, lesions created by the crab, and the microbiota of the crab itself were highly similar, while the microbiota of apparently healthy *D. labyrinthiformis* was significantly different. Manipulative experiments revealed that the removal of the crab from corals with white plague-like lesions and placement onto apparently healthy *D. labyrinthiformis* corals resulted in the development of similar lesions. Microbial analysis suggested that a member of the*Roseobacter* clade may be a potential pathogen of the corals *D. labyrinthiformis* and *P. strigosa*, which may be transmitted by gall crabs of the Cryptochiridae family. This study is the first to examine the microbiota of the coral-dwelling gall crab, and has identified the gall crab as a potential disease vector for devastating diseases such as white plague.

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LOCAL HABITAT INFLUENCES THE RESPONSES OF THE LARGE BENTHIC FORAMINIFERA AMPHISTEGINA LOBIFERA TO THE COMBINED EFFECT OF ELEVATED TEMPERATURE AND NITRATE (Abstract ID: 28282)

Large benthic foraminifera are crucial marine calcifiers in coral reefs, and sensitive to environmental changes. Yet, many species successfully colonise a wide range of habitats including marginal and highly fluctuating environments. This study aimed to identify populations of Amphistegina lobifera that could potentially acclimate to high environmental fluctuations. Specimens were collected from different reef sites on the Great Barrier Reef (GBR) across a shelf gradient of temperature and nutrients, and exposed to the combined effects of elevated temperature and nitrate in lab-controlled conditions for 30 days. We analysed survivorship and fecundity, and are sequencing 18S rDNA from A. lobifera diatom symbionts to investigate flexibility in symbiotic partnerships. Survivor-

ship and fecundity varied significantly among reef sites and experimental conditions. Survivorship was highest (>95%) among inshore reefs exposed to control conditions of temperature and nitrate, whereas outer-shelf populations showed substantially reduced survivorship (<25%) when exposed to the combination of elevated experimental conditions. Fecundity was significantly reduced by elevated temperature across the GBR shelf, and only inshore A. lobifera showed consistent reproduction in all treatments. Initial assessment of diatom composition showed spatial differences in symbiont community composition. These preliminary results showed that local habitat is an important factor shaping the response of A. lobifera to the combined effect of temperature and nitrate.

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3D MAPPING OF CORAL REEFS: VISUALIZATION, CHARACTERIZATION, AND QUANTIFICATION WITH PERMANENT, EXTENSIVE, AND INFORMATION-RICH VIRTUAL DATA SETS (Abstract ID: 28780)

3D mapping of coral reefs provides a unique virtual record of the spatial relationships between reef complexity and its related biota. Imagery is collected using digital still photography and ultra-high definition (4K) videography. Camera arrays can be mounted on dive scooters, ROVs, or AUV platforms depending upon depth, site conditions and project needs. The camera array is "flown" at a height of 1-2 above the sea bottom in a series of overlapping swaths that cover the entire study site. Photographic sequences taken over the reef provide multiple perspectives of the sessile benthic organisms and reef topographic structure. The application of "structure from motion" computer algorithms use 100,000s of these photos, for each site to create a 3D point cloud that accurately records site topography and position and structure of organisms. Point clouds or derived polygonal mesh models can be analyzed as "virtual" models of reef site. These models can be used to determine dimensions of organisms and abiotic features. Incorporating 3D mapping in reef monitoring improves precision and accuracy of field surveys. This computer-based approach captures a permanent record with sufficient detail to perform statistically robust desk-top analysis of complex ecological data. This permanent, "virtual" record also allows the user to employ various ecological methods integrated on this permanent record to answer hypothesis-driven, project specific questions. Importantly, if the questions change in time – so can the resultant, subsequent analysis without the need to acquire additional data.

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PLANNING AND MANAGING MARINE PROTECTED AREAS: FROM BELIEF SYSTEMS TO EVIDENCE (Abstract ID: 29115)

People involved in establishing and managing marine protected areas (MPAs) are motivated by wanting to make a positive difference to the eventual state of the marine environment. In parallel with medicine, education, and development aid, the difference we make in conservation is referred to as "impact". Impact can be evaluated retrospectively, to offer lessons to planners and managers, and estimated predictively, to guide decisions on priorities for conservation investments. But much of the decision-making around MPAs is based more on untested belief systems than on evidence. Effective MPAs require decision-makers to critically assess their assumptions and beliefs about approaches to planning and management. This presentation critiques five aspects of decision-making about MPAs, showing that none of them can be linked reliably to conservation impact: 1. Accumulating km2 2. Establishing large, remote MPAs 3. Management based on criteria for effectiveness 4. Setting criteria-based priorities (e.g. KBAs, EBSAs) 5. Systematic methods to represent species or marine bioregions. All five approaches fail to inform funders and decision-makers about conservation impact and risk being used to over-state progress in marine conservation. A consequence is avoidable degradation of marine ecosystems and loss of marine biodiversity. The barrier to moving to evidence-based decisions for MPAs is not lack of capacity, but lack of willingness to use and refine available tools to look critically at and improve approaches to decision-making about MPAs.

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CORALLINE ALGAE HOST PHYSIOLOGY, MINERALOGY, AND FUNGAL INFECTION DYNAMICS RESPOND TO TEMPERATURE ANOMALIES AND NATURALLY VARYING SEAWATER PH (Abstract ID: 29971)

Recent advances in autonomous sensor technology have illuminated the spatio-temporal complexity of carbonate system dynamics on coral reefs. The consequences for reef organisms experiencing naturally occurring combinations of elevated temperatures and/or acidity are unclear. Ecologically important benthic seaweeds – the crustose coralline algae – which cement coral reefs and attract larvae of reef-building corals, may respond physiologically to dynamic inorganic carbon diel cycling and temperature anomalies. By co-locating autonomous pH/T sensors across 10 sites with long-term (>5 yrs) monitoring plots and transplanted specimens, we demonstrate that net calcification rates (linear extension and calcimass), mineralogy (mole fraction Mg) and relative abundances of coralline algae are positively correlated with the least variable and most benign physicochemical conditions. Further, coralline fungal disease (CFD) prevalence and lesion expansion rates (linear) on individual coralline algae hosts are related to temperature anomalies and can reach 6.5 mm per day. We demonstrate experimentally that ocean-warming events may increase the frequency of CFD outbreaks on coral reefs, but that OA-induced lowering of pH may ameliorate outbreaks by slowing progression within a host. Lowered pH may still impact overall host survivorship, however, by reducing calcification and facilitating fungal bio-erosion. Future research will explore the role of environmental conditions and host coralline mineralogy on disease transmission, severity and population susceptibility to CFD.

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FISH SPAWNING AGGREGATIONS MODIFY MULTI-SPECIES AND -TROPHIC INTERACTIONS (Abstract ID: 28960)

The vast majority of fish spawning aggregation (FSA) research has focussed on the identification, characterisation and monitoring of the focal spawning species. This is understandable given their imperilled status. However, little attention has been paid to the effects FSAs have on resident fish and benthic assemblages, which may be particularly evident during large predatory fish aggregations. Here we use repeated underwater visual surveys and behavioural observations to assess how resident fish and benthic assemblages respond to the natural variation in predator biomass found at a multi-species grouper FSA site in Palau, Micronesia. We found strong risk effects of grouper presence resulting in changes in overall fish assemblage, and decreased excursion areas and bite rates in the ubiquitous surgeonfish, Ctenochaetus striatus. Concurrent increases in turf algal biomass suggest indirect behaviourally mediated effects occur across multiple trophic levels. Such species interactions can be a primary force in structuring communities and food webs, highlighting the wider importance of FSA sites at a time when FSAs worldwide are in decline.

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COMPOUNDING EFFECTS OF CONTAMINATED GROUNDWATER ON CORAL REEF BIOEROSION AND HEALTH (Abstract ID: 28183)

Increased CO2 concentrations from greenhouse gases have been linked to a lowering of surface seawater pH by 0.1 and aragonite saturation state (Ω) by 15%. Global climate models predict an additional change of 0.3 pH units by 2100, triggering a decrease in Ω 5x greater than natural variability over the last millennium. Managing local stressors that exacerbate vulnerability of coral reefs to climate change is therefore of paramount importance. Land-based sources of pollution that alter coastal water nutrient and pH levels can magnify vulnerability to CO2-related impacts, with nutrients and pH acting together to accelerate bioerosion rates. We examine coral reef health, indicated by bioerosion, calcification, and growth rate, in response to multiple stressors from high-nutrient, low-pH submarine groundwater discharge in West Maui. Freshwater discharging directly from groundwater vents off of Kahekili Beach Park in West Maui contains elevated nutrient concentrations and lower pH values than surrounding waters. The range of conditions that corals living in the vicinity of the vents are exposed to is comparable to those arising from end-of-century pCO2 projections, however measured bioerosion rates at Kahekili are greater than those predicted from previous relationships between Ω and bioerosion. Elevated nearshore nitrate and coral tissue δ15N values distinctly reflect the down stream signature of nutrient loading from wastewater effluent injected into the coastal aquifer ~300 m upland of the reef. These results suggest nutrient loading from human

activity is driving a disproportionate escalation of bioerosion rates under low pH/ocean acidification conditions.

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USE OF SEXUAL REPRODUCTION TO ACCLIMATIZE EARLY LIFE STAGES OF CORALS TO CLIMATE CHANGE: WHAT DOES NOT KILL ME, MAKES ME STRONGER? (Abstract ID: 29780)

Restoration in coral reefs involves the use of both reproduction patterns of corals (e.g. sexual and asexual). Nonetheless, sexual reproduction in corals is of paramount importance to ensure high genetic diversity. Transgenerational acclimatization was achieved in corals, but there is almost no information about whether intra-generational effects may also occur. In our work, we hypothesize that early life stages of corals may be preconditioned to thermal stress, meaning that a first exposure to short-term thermal stress may render them more resistant to a second exposure at a later stage. To achieve that, early life stages (gametes and larvae) of Acropora species were pre-exposed to short-term temperature stress (e.g. 30 min to 24h) before the main thermal stress experiment was performed. Our results show that 1h of preconditioning improves the successful fertilization rate of gametes, by a 57.6% increase in fertilization rate. Moreover, both age of the larvae and timing of preconditioning matter in order to acclimate larvae to sub-lethal temperatures. Indeed, non-swimming larvae (2 days old) showed a better capacity to acclimatize to thermal stress than 6 to 10 day old larvae. In conclusion, our results are promising, and revealed that intra-generational acclimatization may occur in Acropora. This has the potential to 1) enhance current restoration efforts of coral reefs by transplanting recruits or larvae with better resistance and 2) improve our knowledge of acclimatization and adaptation processes among key organisms, such as scleractinian corals.

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SIGANUS VIRGATUS IS A KEY BROWSER IN CORAL REEFS OF THE GULF OF THAILAND (Abstract ID: 28481 | Poster ID: 582)

Browsing fish species are important functional players in coral reefs because of their ability to remove macroalgae. Their identification thus has important implications for future management strategies aimed at increasing the resilience of coral reefs. However, very few studies have been conducted outside of the Great Barrier Reef in Australia. This study aimed to identify important browsers at two study sites in the Gulf of Thailand: Mae Haad, a heavily touristic and fished bay dominated by algae and the Marine Park Ang Thong, dominated by hard corals and exhibiting very low algae cover. Findings revealed that more than 90 % of size-adjusted bites taken from macroalgae assays derived from only one species, Siganus virgatus, which dominated feeding in both reefs. Higher size-adjusted bite rate in Ang Thong (11.2 $\pm$ 18.4 msb h-1 vs. 0.7 $\pm$ 2.3 msb h-1 in Mae Haad) coincided with 2.4 times higher biomass of S. virgatus and 10 times higher biomass removal on overnight assays (53 $\pm$ 44 % removed compared to 4 $\pm$ 8 % in Mae Haad). No Acanthurids were observed in either reef. As reefs without Acanthurids often undergo phase shifts, the healthy state of Ang Thong is remarkable. The data suggest a key role of Siganus virgatus for macroalgal removal on coral reefs in the Gulf of Thailand. In the absence of the usual important Acanthurid browsing species such as Naso spp., Siganus virgatus assumed the role as dominant macroalgae remover and should thus be considered more extensively in management and conservation efforts.

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SEASCAPE IDENTITIES; UNDERSTANDING VALUES AND CULTURAL PATTERNS (Abstract ID: 29278)

Seascapes symbolize both the physical dimensions of ocean and coastal areas, as well as the meanings humans ascribe to their observations, interactions, and relationships to the sea. Seascapes have value and contribute to building identities and understanding territories. More than beautiful scenery over the ocean, a seascape is a fluid cultural and geographic space, whose dynamics make it complex to define but should be at the center of analysis. In Pacific Island communities, seascapes are particularly important given that the ocean (1) contributes considerably to the well-being of coastal communities, (2) is an area of high overlap between tourists and residents, and (3) are threatened as our climate continues to change and human pressures are increasing. We will discuss various methods we use to understand seascapes including observation notebooks, interviews, surveys, focus groups, participatory mapping, discourse analysis, and integration of weather, oceanographic, and population data. Seascape maps and results will be presented for a small coastal community of Hilo, Hawaii as an example of these approaches. By interviewing respected ocean observers we are learning more about changes they have witnessed over time and the spatial scales and ocean conditions important to them. Managing complex seascapes requires the integration of both human and mechanical observations to ensure that multiple systems of knowledge are included and valued; strengthening our understanding of seascapes and their resiliency in this changing environment.

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A ROBUST METHOD FOR PREDICTING WHERE TROPICAL CYCLONES DAMAGE REEFS (Abstract ID: 29174)

Tropical cyclones (TC) waves can severely damage coral reefs. Models that predict where such damage occurred (the 'damage zone') enable reef managers to: 1) target management responses after major TCs in near-real time to promote recovery at severely damaged sites; and 2) identify spatial patterns in historic TC exposure to help explain habitat condition trajectories. To provide these capabilities, damage models must be valid for a wide range of TCs, which vary in intensity, circulation size and duration. Here, we map damage zones for 46 TCs that crossed Australia's Great Barrier Reef from 1985-2015 using four models – three from the literature and one we develop to extend the capability of the others. We ground truth model performance with field data of damage from seven TCs of varying characteristics. The model we develop, 4MW, significantly out-performs the other models at accurately capturing damage. The next best performing model – AHF - under-predicted damage for the large and/or long-lived TCs which are most likely to cause widespread damage, and over-predicted damage for short-lived TCs. These two models produce strikingly different spatial and temporal patterns of damage frequency when examining historic patterns in TC damage exposure over the 30-year time series. We conclude that the 4MW model greatly enhances both of the main capabilities TC damage models provide to managers. The 4MW model can be used wherever both TCs and corals occur, such as in parts of SE Asia where reefs frequently experience the largest and most intense TCs in the world.

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MULTI-FACTOR VARIATION IN ARTISANAL SEA CUCUMBER FISHERIES IN OCEANIA (Abstract ID: 30149)

Small-scale fisheries on coral reefs are important to livelihoods of millions of fishers, yet catches, gender participation and livelihood options are often poorly understood. We characterised fishing and fishers in multi-species sea cucumber fisheries using questionnaire-based surveys in multiple regions within each of four countries in Oceania. Many women were fishing sea cucumbers in Fiji, Tonga and New Caledonia, whereas women in Kiribati mostly participated in postharvest processing. Catch-per-unit-effort (CPUE) differed among countries depending on fishing modes and species targeted. Fishers tended to view stocks as declining or greatly over-exploited. In many cases, women received much lower prices than men for their catch. Sea cucumbers were often a primary source of income for fishers, and a majority of them rely on other coastal resources as fall-back income streams. This study shows that fishers and their catches in artisanal reef fisheries can be highly context-dependent. Understanding species composition and catch rates of fishers through sociological surveys will support better fishery management. Management measures and interventions to support fisher livelihoods must consider gender differences and location-specific fishing activities. Our study indicates that closure of certain reef fisheries will likely cause greater pressure on other fisheries unless livelihood diversification programs are developed.

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REVERSING THE DECLINE OF SHARK POPULATIONS IN RAJA AMPAT, EASTERN INDONESIA (Abstract ID: 28500)

The high marine biodiversity and natural beauty of Raja Ampat, Indonesia attracts not only dive tourism but also outside fishers, who often engage in destructive and illegal fishing, including the targeting of sharks for their economically valuable fins. Since 2009, Raja Ampat local government made several efforts to improve shark conservation, including: media campaign; develop surveillance system that includes monitoring shark fishermen activities; and develop prohibit shark fishing regulation. The declaration of 4,6 million hectares marine areas as a Raja Ampat shark sanctuary in December 2012 was the first of its kind for Indonesia and for the Coral Triangle. Since the declaration of the shark sanctuary, the Indonesian government has been supporting the enforcement of the shark finning ban, with several illegal fishers being caught and prosecuted. Shark populations have been surveyed approximately annually from 2009 to 2015 as part of routine reef fish monitoring. Preliminary results indicate shark populations inside MPAs have increased five-fold after three years the sanctuary was implemented. Whereas outside MPAs, shark populations are increased two-fold. This is further reinforced by anecdotal evidence from local patrol team observations on the reappearance of juvenile shark populations in several areas. Amidst an overall trend of shark population decline in Indonesia, this shark sanctuary is showing a promising outlook for the recovery of shark populations in Raja Ampat, providing a model for other regions in the Coral Triangle and beyond.

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A ROLE FOR INDUCIBLE DNA METHYLATION IN CORAL INTRA- AND CROSS-GENERATIONAL ACCLIMATIZATION TO FUTURE OCEAN CONDITIONS (Abstract ID: 28934)

As climate change intensifies and the pace of warming and ocean acidification increases, reef-building corals must acclimatize to persist. One mechanism of intra- and cross-generational acclimatization (IGA, CGA) is inducible DNA methylation and its associated phenotypic plasticity. In a series of experiments we have identified 1) CGA of Pocillopora damicornis larval metabolism to high temperature and low pH, 2) beneficial parental effects on juvenile survivorship and growth following adult preconditioning to low pH during brooding, and 3) IGA of adult P. damicornis associated with changes in host DNA methylation induced upon exposure to low pH, together supporting a role for acclimatization through DNA methylation. We then tested the hypothesis that inducible DNA methylation is heritable, associated with changes in gene expression and has performance consequences for P. damicornis adults and offspring after exposure to ambient (~27 °C) and future temperatures (~29 °C). Adults and offspring were collected prior to exposure and after larval release at 1, 2, and 3 months for comparison of DNA methylation and gene expression patterns. Thermal performance curves of larval respiration and survivorship across 5 temperatures (26-34 °C) suggest a shift to higher thermal tolerance in offspring whose parents were exposed to higher temperature. Together with ongoing RNAseq and reduced representation bisulfite sequencing data, these results indicate a strong role for dynamic DNA methylation in rapid CGA with implications for coral performance in a future of climate change.
http://www.hollieputnam.com/

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MARINE CONSERVATION MANAGEMENT OF KRAKATAU ISLANDS, INDONESIA (Abstract ID: 27897 | Poster ID: 568)

The Krakatau Islands form a group of isolated, uninhabited, but accessible volcanic islands in the Sunda Strait between Sumatra and Java (Indonesia Archipelago). Their geological growth and development are well documented. Based on an Indonesian Government decision, the Krakatau complex was designated as a Natural Reserve, consisting of Marine Reserves and Nature (land) Reserve. The present report provide suggestions concerning their marine conservation management in relation to natural and anthropogenic disturbances. The result showed the ongoing impact of the anthropogenic disturbances (i.e. destructive recreational activities) on coral communities in the area will continue to lead to degradation in the future unless the utilization of the area will become more controlled.

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LONG-TERM CHANGES AND RESTORATION MEASURES OF SOFT CORALS (*DENDRONEPHTHYA* SPP.) AT MU KO SIMILAN NATIONAL PARK, THE ANDAMAN SEA (Abstract ID: 28667 | Poster ID: 678)

Soft corals, *Dendronephthya* spp., are members of 19 genera (in four families) of soft corals found in Thai waters. In the Andaman Sea, *Dendronephthya*spp. is dominant at several coral reefs. Their beauty and color attract divers to these reefs making them popular diving destinations. In this study, we investigate the long-term changes of the soft corals, *Dendronephthya* spp., from 2009 – 2013 in three study sites of the Mu Ko Similan National Park, one of the most frequented diving destinations in the Andaman Sea. We found that the average percent covers of *Dendronephthya* spp. spp. were significantly different among the study sites. The highest coverage of*Dendronephthya* spp. was observed at West of Eden while the lowest one was recorded at Ao Faiwab. Significant temporal variation was also detected among years. Reduction in soft coral bottom cover as influenced by certain environmental factors and rapid growth of tourism. The number of tourists visiting Mu Ko Similan in 2013 was nearly doubled compared to that in 2011. Based on our analysis, controlling tourism impacts on soft corals could be possible by implementing the following measures: 1) setting appropriate management action plan with the implementation of effective enforcement and regulation of diving activities; 2) establishing zoning and their appropriate carrying capacity for tourists in certain areas and 3) enhancing research and techniques on soft coral restoration.

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THE HABITAT PERSISTENCE HYPOTHESIS: A NEW PERSPECTIVE ON THE DISTRIBUTION OF CORAL-REEF ORGANISMS (Abstract ID: 29098)

We propose the "Habitat Persistence Hypothesis" (HPH) to explain patterns of diversity on tropical coral-reefs. We reviewed distributions of organisms inhabiting tropical coral reefs, and formulated the HPH to account for biogeographical patterns on both shallow (<30m) and deep (30–150m) coral-reef habitats. Species occurring on deep reefs appear to show higher rates of endemism and less eastward diversity attenuation than their counterparts on shallow reefs. The HPH stipulates that shallow-reef habitats persist across glacio-eustatic sea-level changes in regions with sloped bathymetry (e.g., continental regions and large islands), but are largely extirpated during low sea-level stands in regions with steep bathymetry (e.g., coral atolls); in contrast to deep-reef habitats, which persist in all regions. The HPH suggests that habitat persistence results in higher rates of endemism, and that patterns of attenuating diversity with distance from centers of species richness reflect recolonization from areas with shallow-habitat persistence. Whereas existing hypotheses that attempt to explain biogeographic patterns rely on observations limited to shallow (<30m) coral-reef habitat and invoke processes operating on speciation time-scales (~10^7 yr), the HPH also incorporates patterns on the remaining 80% of coral-reef habitat (30–150m), and invokes processes operating on time scales associated with sea-level changes (~10^5 yr). The HPH posits seven specific predictions that can be directly tested to distinguish its role from existing coral-reef biogeographic hypotheses.

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CORALLINE ALGAE DISEASE REDUCES SURVIVAL AND SETTLEMENT SUCCESS OF CORAL PLANULAE IN LABORATORY EXPERIMENTS (Abstract ID: 28836)

Coral reef diseases have increased in frequency and severity, spread worldwide and threaten to worsen with changing environmental conditions. Disease outbreaks have been involved in the deterioration of coral reefs and have been particularly striking among crustose coralline algae (CCA). Although CCA represent important cues for coral settlement, the impact of CCA diseases on the survival and settlement of coral planulae is unknown. Exposing coral larvae to healthy, diseased, and recently dead crusts from three important CCA species, we show a negative effect of disease in the inductive CCA species *Hydrolithon boergesenii* on larval survivorship of*Orbicella faveolata* and settlement of *O. faveolata* and *Diploria labyrinthiformis* on the CCA surface. No effect was found with the less inductive CCA species *Neogoniolithon mamillare* and *Paragoniolithon accretum*. Additionally, a majority of planulae that settled on top of diseased*H. boergesenii* crusts were on healthy rather than diseased/dying tissue. Our experiments suggest that CCA diseases have the potential to reduce the survivorship and settlement of coral planulae on coral reefs. Exacerbated under climate change conditions, the impacts of diseases on CCA could potentially hamper the resilience of coral reefs. This study aids understanding of disease cascading effects on reef communities.

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VARYING LEVELS OF HERBIVORY AND NUTRIENT CONDITION MEDIATE CORAL SETTLEMENT SUCCESS (Abstract ID: 29266)

Herbivores play an important functional role in regulating the proliferation of algae in coral reef ecosystems. A short-term caging experiment was designed to investigate the role of herbivorous fishes on coral settlement at three sites in Bacuit Bay, Philippines. Coral settlement tiles were subjected to the following herbivore exclusion treatments: caged, partially caged and no cage, set at 5 m intervals along 50-m transects. After six months, tiles were retrieved and brought to the laboratory for microscopic analyses. To correlate spat abundance and densities with potential reef fish herbivores, underwater fish visual census was undertaken along the same transect. Water samples were collected at 1 m depth and 1 m above the reef at 15 m intervals along transects to measure nutrients. Preliminary results reveal that mean coral settlement rate was highest at Tres Marias (4.3 ± 0.7) followed by Depeldet (3.2 ± 0.6) and South Miniloc (0.8 ± 0.3). Experimental treatments that were open to herbivore grazing resulted in higher rates of coral settlement at Tres Marias and Depeldet, because herbivores mediated coral-algal competition. However, at South Miniloc, the herbivore exclusion treatments resulted in the highest numbers of coral settlers, which seem to suggest that incidental predation by herbivores reduced coral settlement in the partial and open treatments. There was no significant difference in phosphate and nitrate concentrations across sites, however, ammonium concentration was two-fold higher in Depeldet compared to South Miniloc which could favor algal growth.

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CATCH TRENDS IN MARINE TROPHIC GROUPS: AN EVALUATION OF SELECTED MARINE KEY BIODIVERSITY AREAS IN THE PHILIPPINES (Abstract ID: 29310 | Poster ID: 579)

Overfishing is a rampant ubiquitous phenomenon attributed to human-induced impacts. Fisheries are often selective towards high trophic groups (TG), progressing towards low TG as the former becomesdepleted (i.e. fishing down the food web). Determining the catch trends per TG in conservation hotspots or Marine Key Biodiversity Areas (MKBAs) is vital towards successful management and sustainability of the fisheries. This study investigates the catch trends per TG through time in 3 selected Marine Key Biodiversity Areas in the Philippines. Moreover, a snapshot comparison in fishing gears used in the past and present as well as overall catch per trip per gear was also determined. Quantitative estimates of catch trends and gear history were obtained using 1 on 1 interviews with the local communities. Fish catch were grouped into 8 TG by clustering similar trophic levels (TL) obtained from FishBase (www.fishbase.org). Catch per trip for all the sites in the past and present were composed of both high and low TG with the latter comprising the bulk. Catch per trip for all TG initially increased during the 1950s and 1960s. However, catch per trip has been on a gradual decline since the 1970s until the present. Gear composition per site were similar between past and present, however, catch per trip was higher in the past. The results indicate that fishing down the food web is experienced in the 3 MKBAs. Management interventions such as MPA establishment, catch quotas, close season and alternative livelihoods should be pursued to ensure fisheries sustainability.

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COMPLIANCE MANAGEMENT IN THE GREAT BARRIER REEF WORLD HERITAGE AREA (Abstract ID: 29198)

Protecting the world-renowned beauty and biodiversity of the Great Barrier Reef World Heritage Area and providing a level playing field for all users are key aims of the compliance management undertaken by the Australian and Queensland State governments' joint Field Management Program. This compliance program is risk-based and involves assessing the impact of illegal activities and the likelihood of them occurring. This is used to focus the compliance programs core functions of intelligence, surveillance and investigations on those activities of the highest impact and risk. To ensure effective compliance with relevant legislation the program is coordinated by a central compliance unit that works with and coordinates the efforts of the multiple Australian and Queensland government agencies that participate in the compliance management of the Great Barrier Reef World Heritage Area. The approach to compliance management consists of education, aerial surveillance, vessel patrolling, remote surveillance and audits of activities that require a formal permission. The aim is to achieve high levels of voluntary compliance and use enforcement where warranted. Increasingly the program is incorporating technological enhancements and new administrative measures to tackle recidivist behaviour where traditional approaches may be limited. It is the combination of a strategic risk-based program and incorporating new tools that enables the compliance program to be flexible and tackle emerging issues to assist in protecting the values of the Great Barrier Reef World Heritage Area.

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EFFECTS OF INORGANIC NUTRIENTS ON CORAL PRODUCTION OF FLUORESCENT DISSOLVED ORGANIC MATTER (Abstract ID: 29769 | Poster ID: 93)

Photosynthetic benthic organisms in tropical reefs all exude a portion of their primary production as dissolved organic matter. Understanding the composition and fate of this organic matter is central to a holistic characterization of coral reef ecosystem metabolism. We experimentally examined the effect of a gradient of nitrate and phosphate enrichment on the quantity and composition of exudates produced by corals during a multi-week chemostat incubation. We characterized temporal shifts in the spectral characteristics of fluorescent dissolved organic matter (fDOM) using scanning fluorescence spectroscopy and measured concentrations of dissolved organic carbon, nitrogen and phosphorus. While bulk measures of dissolved organics remained stable across a gradient of nutrient enrichment, fDOM exudates from corals were compositionally distinct from ambient pools and nutrient addition altered coral-derived fDOM in specific fluorescent regions that may indicate differential production and consumption of organic compounds by corals under shifting inorganic nutrient regimes. Our results are relevant to understanding coral organic exudation and the impacts of anthropogenic pollution on reef organic matter cycling.

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RESILIENCE OF THE CORAL REEFS FISH POPULATIONS ON THE PADANG SHELF REEF SYSTEM, WEST SUMATRA, INDONESIA, AFTER THE 1997 MASSIVE CORAL DIE OFF (Abstract ID: 28173 | Poster ID: 211)

Quantitative surveys of six coral reefs of the coast West Sumatra began in the latter decade of the 20th century. Then, as many as 50% of the reefs were classified as degraded, primarily because of blast fishing. Some of the reefs surveyed were in an area that subsequently became the Marine Tourism Park Pieh Island. In 1997, reefs in the Padang Shelf Reef System experienced a massive die off associated with the Indian Ocean Dipole where an upwelling caused by unusually strong winds increased nutrient levels in the ocean and a drop in water temperature by >4oC. Together with aeolian Fe from wildfires in Sumatra, oceanic nutrient levels were elevated to a point where a massive red tide event occurred and persisted for six months. Live coral cover (LLC) declined to 0% to a depth of at least 10-15m and many of the obligate coral reef fish populations were extirpated. In 2014, nearly 17 years after the die off, the reefs were resurveyed. All the surveyed reefs experienced increased live coral cover with some sites up to 70%

LCC and a recovery of many of the fish populations with 28 families observed. Only four fish families were recorded at all eight sites: Chaetodontidae, Labridae, Lutjanidae and Pomacentridae. The most abundant family, the Pomacentridae, comprised 30.1% of the fish recorded. Species common in 1996, but not recorded in 2014 were Heniochus moncerus and C. oxycephalus. The most abundant Chaetodon in 1996, C. trifascialis, was ranked 10th in abundance in 2014. Three species with a ranking of >10 in 2014 were not recorded in 1996: Chaetodon kleinii – Rank 3, Heniochus singularius – Rank 4, Forcipiger longirostrus – Rank 6.

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MONITORING LA REUNION AND MAYOTTE CORAL REEFS (WESTERN INDIAN OCEAN) DURING EXPECTED EL NIÑO EVENT (Abstract ID: 28706 | Poster ID: 342)

Scientists and volunteers of Reef Check France have been surveying La Reunion's and Mayotte's coral reefs for 15 years. Due to the occurrence of an El Niño phenomenon, a bleaching event took place during the austral summer 2015-2016 period in the Western Indian Ocean. Studies during previous events (1997-1998; 2001-2002) showed that there exist variability in extent and severity from site to site. Fortunately, the studies revealed areas with a good resilience. Since 2005, Reef Check France has monitored 18 reef stations in Reunion Island and 7 reef stations in Mayotte Island. To monitor the 2015-2016 bleaching event, Reef Check France and partners has selected some "sentinel stations" to implement surveys, from March to May 2016, during and right after the hottest critical period. Coral monitoring has been completed including a temperature record. Results will be compared with existing datasets to assess, if any, differences in hard coral cover, including bleached coral cover, dominant coral forms, macroalgae cover, and temperature relationships. Reef Check, operated by volunteers, use two world-wide basic protocols to survey coral bleaching, which so can't provide species or genera richness comparison. Even so, it is rapidly and easily implemented during field studies and complementary to more costly research programs. Nevertheless, here, local team leaders (marine scientists) were able to implement a "Reef Check+ bleaching" protocol, more accurately to report the coral genus that has been concerned. Three protocols are thus adequate and efficient tools to rapidly assess a bleaching event and so help decision makers in management issues.
http://www.reefcheck.fr/

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MODERN MICROGASTROPOD COMMUNITIES DRIVEN TO DEEPER WATER IN RESPONSE TO DECLINING WATER QUALITY IN THE MORETON BAY MARINE PARK, QUEENSLAND, AUSTRALIA (Abstract ID: 29540)

Subtropical marginal reefs in Moreton Bay Marine Park (MBMP), have experienced episodic reef growth during Holocene related to periods of sea level and natural climate change. To explore patterns of ecosystem change during these periods of reef growth, we examined the community structure of microgastropod assemblages throughout 7500 years of the Holocene, using data from six sediment cores and 30 grab samples collected at three sites, Wellington Point, Peel Island and Myora Reef in MBMP. Sample age was estimated by interpolating 35 radiocarbon dates. Non-parametric analysis of microgastropods indicated no overall change in community structure over almost the entire temporal sequence (~7500 to ~160 years BP). Despite this apparent ecological persistence through time, analysis of microgastropods from individual reef sites shows significant differences in community structure, both among reefs over time as well as between fossil and modern assemblages. When comparing Holocene microgastropod assemblages in 'shallow' and 'deep' paleodepths with modern 'shallow' and 'deep' depths, we observed modern 'deep' microgastropods communities from Myora Reef occurring in deeper waters than their fossil counterparts. These results suggest a decline in water quality in the modern habitat (~1840) causing habitat shift from shallower subtidal to deeper subtidal waters. Paleoecology and modern ecology studies can help identify natural variability versus anthropogenic impact to improve understanding of the future response of benthic marine communities to human and climate change impacts.

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VARIATIONS IN CORAL MICROBIOMES AMONG INDONESIAN REEFS WITH DIFFERENTIAL LEVELS OF BLEACHING (Abstract ID: 29884)

In some Indonesian waters, corals have suffered mass bleaching due to increasing ocean temperatures, especially during El Nino events. However, corals in different regions of Indonesia appear to respond differently to this thermal stress. Corals have a flexible relationship with their symbionts, which vary in their ability to withstand or recover from environmental stress. In addition to Symbiodinium, corals also host other types of symbionts, including bacteria and archaea, that might have roles in affecting the coral's response to elevated temperature. In order to evaluate the relationship of associated bacteria and archaea to the coral's response to elevated temperature and subsequent bleaching, we conducted a temperature stress experiment on three species: Acropora millepora, Pocillopora verrucosa, and Porites lobata, from a reef in West Papua that experienced very mild bleaching during 2010 El Nino event followed by recovery, as well as Porites lobata from two locations in Bali that experienced different levels of bleaching. Following a common garden experiment in which coral fragments were exposed to temperatures of 30oC as control, 32oC, 34oC, and 36oC, we sequenced 16S to assay changes in microbial diversity. Deep-sequencing analyses revealed substantial variation in microbial reefs associated with different levels of bleaching stress, with strong host-specific microbiome profiles. Variation of microbial communities associated with differential host responses to temperature stress indicates the potential role of the microbiome in aiding the coral's response to environmental stress.

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INFLEXIBILITY OF THE MICROBIOME DRIVES HOLOBIONT BREAKDOWN DURING EXCESS NITROGEN AVAILABILITY (Abstract ID: 28556)

The symbiosis between corals and photosynthetic algae of the genus Symbiodinium provides the foundation to the success of corals in tropical oligotrophic waters. The persistence of this symbiosis is facilitated by a constant nitrogen (N) limitation of the algal partners, adjusting symbiont cell division rates to those of the coral host. Recent studies proposed that shifts in the coral microbiome and associated microbial N-cycling pathways may help corals to maintain this N-limitation even under eutrophic conditions. To test this hypothesis, we aimed to release Symbiodinium populations from N limitation in hospite by exposing colonies of Pocillopora verrucosa to excess N-enrichment in a two-week aquaria experiment at the Central Red Sea. Strikingly, the overall structure of bacterial and Symbiodinium communities was stable throughout the experiment, thereby suggesting that the ability of the microbiome of P. verrucosa to adjust to changes in environmental conditions is limited. Consequently, Symbiodinium densities tripled over the course of the experiment. This likely resulted in retention of photosynthates, and starvation of the coral host, as further highlighted by tissue lesions in week two. We argue that the inflexibility of the microbiome may limit the potential of P. verrucosa to counteract excess N enrichment making it highly susceptible to eutrophication.

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THE INFLUENCE OF UPWELLING ON THE TROPHIC STATUS OF CORALS FROM THE SHALLOW AND DEEP SLOPE IN THE CENTRAL MALDIVES (Abstract ID: 28980)

Upwelling stimulates primary productivity, which is known to support megafauna but the influence of upwelling on coral is understudied. Nutrient availability and light are important for coral symbiosis with increasing depth. Here we use natural abundance stable isotopes to examine the assimilation of carbon (d13C) and nitrogen (d15N) by the coral host and algal symbiont. We investigate how depth, reef exposure and atoll position affects the trophic status of three corals. The central Maldives is a unique location to study

the influence of upwelling on coral reefs due to its bathymetry and monsoonal climate. Temperature records reveal cold-water influxes extend to the deep (30 m) slope, but not shallow (10 m). Depth and genus significantly affected both isotope compositions. d13C values significantly differed among coral, with a spectrum of heterotrophy to autotrophy for Pocillopora and Pachyseris, respectively. Depth significantly affected coral trophic status, particularly Galaxea, which relied more on heterotrophy at 30 m. Differential d13C may also indicate diverse fractionation patterns in the symbiont, which we investigate next. d15N suggest that deep-water nitrate is a primary nitrogen source for these corals. Moreover, the interaction of i) coral, depth, and atoll position, ii) coral and reef exposure, and iii) reef exposure and atoll position had a significant effect on both isotope values of host and symbiont. Our results provide insight into factors influencing coral trophic status, which is important to consider for coral fitness especially during thermal stress.

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FISH DIVERSITY OF THE ANDAMAN AND NICOBAR ISLANDS (Abstract ID: 27777 | Poster ID: 81)

ABSTRACT Andaman and Nicobar islands situated in the Bay of Bengal between 6o45´ - 13 o 45´ N and 92o10´ – 94o15´E, consist of 572 islands, islets, rocks and cover a distance of almost 800 km over North-South, with a coastline of 1962 km, and bring in for India an Exclusive Economic Zone (EEZ) of 600 thousand km². The shelf topography of these islands show frequent rises supporting coral reefs, which are characterised as fringing reefs on the eastern side and barrier reefs off west coast; the depressions are known as passages and straits. Besides coral reefs, the shore is composed of rocky and sandy areas and vast stretches of mangrove swamps. Owing to the varied marine habitats, ichthyofauna of these islands is observed to be one of the most diverse in the world. The fish diversity in these waters also receives special attention in terms of marine zoogeography because of the confluence of Andaman Sea fishes with Western Pacific and the Indian Ocean. A total of 1489 species of fishes belongs to 580 genera and 165 families were reported from Andaman and Nicobar Islands, of which 139 species belonging to 57 genera are gobies. Family Gobiidae, the largest group in perciformes, includes approximately 2000 species which belong to 212 genera and nine families. As of today from these islands, as many as 62 species of marine fishes are threatened (IUCN, 2014), 4 of them Critically Endangered, 2 Endangered and 40 Vulnerable. Of the 62 threatened species, most of them (46) are cartilaginous fishes or elasmobranchs—sharks, skates and rays—and the remaining 9 are teleost, i.e. bony, fishes. KEY WORDS: Fish diversity, Distribution, Conservation, Andaman and Nicobar Islands
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SIGNIFICANT INCREASE OF ALCYONACEANS IN VILANGUCHALLI PATCH REEF, GULF OF MANNAR, INDIA (Abstract ID: 28782)

Alcyonaceans are an integral part in any healthy reef ecosystem, but have been given very little attention. Here we report a significant increase of alcyonaceans in Vilanguchalli patch reef of Gulf of Mannar, India where alcyonaceans have been poorly documented. Data collection was done between 2013 and 2015 on three permanently marked line intercept and belt transects. Significant fluctuation in both scleractinian and alcyonacean cover was observed along the transects. Scleractinians decreased from 29.81 to 21.75% whereas alcyonaceas increased from 19.63 to 30.47%. A total of 7 alcyonacean species belong to 4 genera were recorded and Sinularia (79.28%) followed by Cladiella (13.91%) were the dominant genera. Alcyonaceans outgrew the scleractinians making considerable coral mortality in Vilanguchalli patch reef. Acropora formosa and Montipora divaricata were the affected scleractinian species with an average mortality of 8.61 and 1.01% respectively. Corals in Gulf of Mannar show resilience after the halt of coral mining in 2005. Substrate availability and fast growing nature have resulted in increased alcyonaceans cover. Studies are in progress to understand their reproductive season and recruitment.

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A NOVEL GLOBAL PLATFORM FOR MONITORING CORAL HEALTH: CORALSPEQ (Abstract ID: 28663)

Peter Ralph, Atsuko Kanazawa, David Kramer, Milan Szabo, Joey Crosswell, Mathieu Pernice, Madeline Combe, David Suggett CoralspeQ is a novel optical sensor array that has been deployed to assess reef condition exposed to the 2016 El Niño mass bleaching event. The sensor is a handheld, submersible, low cost device, which comprises a microspectrometer with a series of LEDs to measure fluorescence and reflectance of algal and host pigments. Corals are exposed to a combination of excitation light and the resulting emission spectra are captured for analysis, including the ratio of fluorescence emission required to yield photosynthetic health. Field validation trials have shown the utility of this instrument to identify shifts in both host and symbiont pigments (green and orange fluorescent pigments), as well as assessing changes in the photosynthetic properties of the symbiont. Data processing is performed by cloud-based analytical routines available to all users, such that once the data archive becomes significantly large it opens the possibility for "big data" style analysis. We have already distributed units to marine park rangers around the globe. This novel sensor provides the first globally operational platform for long-term community-based monitoring of reef health, as well as a synoptic but standardised and "on the ground" measure of coral condition desperately needed to improve predictive algorithms of bleaching and disease susceptibility. The CoralspeQ is part of the PhotosynQ family of instruments developed by the Kramer Lab at Michigan State University.

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PLASTICITY OF ESCAPE RESPONSES: HOW EXPERIENCED CORAL REEF FISH ALTER THEIR ESCAPE PERFORMANCE (Abstract ID: 28283)

Teleost and amphibian prey undertake fast-start escape responses during a predatory attack in an attempt to avoid being captured. Although previously viewed as a reflex reaction controlled by the autonomic nervous system, the escape responses of individuals when repeatedly startled are highly variable in their characteristics, suggesting some behavioural mediation of the response. Previous studies have shown that fishes are able to learn from past experiences, but few studies have assessed how past experience with predators affect the fast-start response. Here we determined whether prior experience with the smell or sight of a predator (the Dottyback, Pseudochromis fuscus) affected the escape response of juveniles of the Spiny Chromis (Acanthochromis polyacanthus). Results show that individuals exposed to any of the predator cues prior to being startled exhibited a stronger escape response (i.e., reduced latency, increased escape distance, mean response speed, maximum response speed and maximum acceleration) when compared with controls. This study demonstrates the plasticity of escape responses and highlights the potential for naïve reef fish to take into account both visual and olfactory threat cues simultaneously to optimise the amplitude of their kinematic responses to perceived risk.

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COASTAL MULTI-SPECIES SMALL-SCALE FISHERIES: INTERACTION AMONG CORAL REEF, SEAGRASS AND ARTIFICIAL REEFS (Abstract ID: 29729)

Management of small-scale fisheries usually involve monitoring and control of landings. However, the link between fisheries and habitat remains poorly studied and understood. In order to evaluate the effort led by fisheries on resources and on the sea bottom of coastal areas, the Amerindian Wayuu community of the Colombian Caribbean performed a participatory monitoring. Along the 90 km stretch of coastline, 51.117 daily trips were recorded from 2006 to 2014. The removed biomass of target species by gear as well as used habitat by fleet were studied through multivariate analyses using PRIMER and PERMANOVA routines. Our findings show that in early studied years, the target species (snappers, grunts and lobsters) werelargely caught on coral reefs and hard bottom. However, since 2009 an uncontrolled deploying of artificial reefs upon seagrass and coral reef was promoted by the speargun and encircling gillnet fleets, respectively. Consequently, a strong impact is occurring on both target species and habitat. The lane snapper and the white grunt, which are the highest valued and the most landed species, respectively, largely reduced their total catches. Besides, several species of parrotfish that contribute to coral reef health were greatly removed from ecosystem. Additionally, the artificial reefs were involved in the largest catches of small sizes of spiny lobster. Consequently, coral reef and seagrass were affected by fleet operations and deployment of artificial reefs. An adequate sustainability of fisheries should involve management of fishing substrate.

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FUNCTIONAL REDUNDANCY IN EASTERN TROPICAL PACIFIC REEFS (Abstract ID: 29435 | Poster ID: 511)

Analysis of functional diversity in coral reefs have been mainly based in the study of fish communities without considering the ecological role of macroinvertebrates. In this study we calculated functional diversity of an assemblage of fish and macroinvertebrates species resident in the tropical eastern Pacific (TEP) on the basis of morphofunctional groups (MFG) formed from information of trophic level and body measures. Visual census (n= 854) were performed in 18 sites of the TEP distributed in four biogeographic provinces: Cortes, Mexican, Panamic and Oceanic islands. Functional richness, diversity and evenness were calculated for each province and compared statistically, and a regression analysis between taxonomic and functional diversity was made to evaluate ecological redundancy. A total of 257 species were recorded, resulting in 27 MFG. There were significant differences in all indices, with the highest total biomass and richness of MFG occurring in the Cortes and Oceanic islands provinces, and the highest functional diversity in the Mexican province. Finally, there was a positive relationship between species and functional diversity, which followed a power model and presented similar slope values for all provinces. This result represents the evidence of functional redundancy in the TEP reef assemblage at similar levels in all the region. However, the dominance and distribution of biomass in the MFG is different between provinces: Oceanic island's reefs presented higher biomass of predators attributed to less fishing pressure in these areas.

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FIVE MPAS, ONE NETWORK: DESIGNING PUERTO RICO'S NORTHEAST MARINE CORRIDOR (Abstract ID: 29571 | Poster ID: 647)

Puerto Rico's Northeast Marine Corridor is a network of five marine protected areas encompassing an area of over 100 square miles. It has high coral cover, extensive seagrass beds, endangered coral species, marine mammals and important turtle nesting beaches. It also provides an economically and culturally important area forrecreation including tourism and commercial fishing. The main human threats are boater activity, fishing pressure and land-based sources of pollution. A management plan and a local management support group are being developed after three years of research, including coastal hydrodynamics, ecological characterization, and social and economic uses of the area. Several management measures being considered for implementation are no-anchoring zones, expansion of existing no-take areas, and restriction of human uses in ecologically sensitive areas. Given the large extent of the reserve network, a co-management structure based on "ridge-to-reef" approach is being considered for the several territorial and federal agencies with jurisdictional responsibilities over the area. The marine corridor along with the management approach being taken is the first of its kind in Puerto Rico. The design and approach could provide and example for use not only in the broader Caribbean region, but globally as well.

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THE EFFECTS OF A CHANGING MARINE ENVIRONMENT ON THE BIOERODING SPONGE *CLIONA ORIENTALIS* (Abstract ID: 28862)

Excavating sponges, such as *Cliona* spp., break up the coral reef substratum thereby influencing net reef accretion. Sponge erosion is expected to accelerate as oceans become warmer and more acidic, with *Cliona* expected to play a major role in future reef growth. In addition, a greater abundance of *Cliona* is evident at sites with poor water quality, suggesting that sponge erosion will have a greater impact on inshore reefs. This project investigated the effects of temperature, dissolved nutrients, and ocean acidification on *Cliona orientalis* and its associated *Symbiodinium*. Sponges were exposed to temperatures increasing from 23-32C to quantify the ability of *C. orientalis* to acclimate to elevated sea surface temperature. As seen in many coral species, the sponge symbiosis bleached at high temperatures and the photosynthetic capacity of *Symbiodinium* was compromised. In a separate experiment, cores of *C. orientalis* and *Porites* sp. were simultaneously exposed to elevated $pCO_2$ and dissolved nutrients to evaluate whether the two taxa respond similarly to stressors associated with inshore coral reefs. Erosion, calcification, respiration, and photosynthetic rates indicate that the two taxa exhibit differential responses to the combined stressors. *C. orientalis* had less severe responses to elevated nutrients and elevated $pCO_2$ than *Porites*sp., suggesting that the bioeroding sponge is more likely to tolerate future conditions on inshore reefs.

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*BRIAREUM ASBESTINUM*: A TALE OF ONE HOST WITH TWO MORPHOLOGIES AND *SYMBIODINIUM* (Abstract ID: 28299)

The octocoral *Briareum asbestinum* exhibits branching and encrusting morphologies at the same shallow water Caribbean habitat. We investigated the symbiosis between *Symbiodinium* and these morphs at ambient and elevated temperatures. The branching and encrusting *B. asbestinum*harbored *Symbiodinium* types B21 and B19, respectively. Encrusting fragments exhibited lower algal photochemical and light absorption efficiencies, in part due to colony orientation and the nearly three times higher irradiance levels experienced by their polyps. But, the *Symbiodinium*in both morphs were probably acclimated to similar irradiances, as evidenced by the light-limited portion of photosynthesis-irradiance curves and the intracellular chlorophyll concentrations. Encrusting *B. asbestinum*had more *Symbiodinium* and chlorophyll *a* per host surface area, leading to higher photosynthetic rates $cm^{-2}$. Unlike in many scleractinian corals, elevated temperature did not cause bleaching in either *B. asbestinum*morphology, although the coping mechanism differed. At the elevated temperature, *Symbiodinium* in the branching morph made small changes to photochemical efficiency and exhibited a lower photosynthesis to respiration ratio while the algae in the encrusting morph reduced maximum photochemical efficiency. The host morphologies also differed in polyp expansion behavior and protein content. *B. asbestinum* demonstrates different strategies dependent on host morphology and the host-*Symbiodinium* genotypic combination.

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HINDCASTING RELATIONSHIPS BETWEEN THE ENVIRONMENT AND OUTBREAKS OF CORAL DISEASES IN THE CARIBBEAN (Abstract ID: 29643)

Disease outbreaks have contributed to the significant loss of coral populations in the Caribbean, and occur when the tripartite relationships among the coral hosts, the pathogens, and the environment are altered. Yet, it is unknown what role historical and contemporary environmental conditions play in driving coral-disease dynamics. Here we used boosted-regression tree models to hindcast the relationships between outbreaks of four Caribbean-coral diseases and a suite of abiotic and biotic predictors. We parsed the data into temporal windows — before and after major thermal-stress events — to examine whether the relationships changed through time. In general, the predictive performance of the models weakened from 1997 to 2012. This weakening could be indicative of: (1) the potential adjustment of coral populations to local conditions, (2) the loss of susceptible individuals from the populations, or (3) a decrease in disease-transmission due to decreased coral densities. A cyclical pattern was observed in the response of yellow-band disease on Orbicella spp. to maximum sea-surface temperature. Relationships were weak before the thermal-stress events, whereas after 1998 and 2005, there were strong negative relationships. A similar cyclical pattern was observed in the response of white-band disease on Acropora spp. to sea-surface temperature metrics. These results suggest that Caribbean-coral diseases experience long-term fluctuations, but whether these interactions with the environment are biased toward the hosts or the pathogens will determine future trends.

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INTEGRATING CORAL RESILIENCE PRINCIPLE TO CLIMATE CHANGE INTO MARINE PROTECTED AREAS MANAGEMENT: A SUCCESSFUL EXAMPLE OF ADAPTIVE MANAGEMENT IN THE WIO (Abstract ID: 30165)

The first MPAs in Madagascar were established before the 1990s, when the notion of coral reef resilience was not yet popularized. In recent decades, the concept of resilience became more salient and essential for improving coral reef conservation. Effective management requires continuous feedback to reach the established goals and achieve tangible conservation benefits. Here we demonstrate how the integration of coral reef resilience concepts into MPA management led to successful conservation actions by the park authorities in Madagascar. In March 2014, monitoring for reef resilience was conducted in four of Madagascar's oldest MPAs (Nosy Antafana, Tanjona, Masaola and Tampolo). Two stations in each MPA were sampled to assess six parameters of reef resilience: benthos cover, coral recruitment, coral Shannon-Wiener diversity index, coral bleaching, invertebrate abundance and herbivorous fish biomass. The results indicated a similar biomass of herbivorous fish in all sites (380.84±80.78 kg/ha). Coral recruitment (colonies of juveniles/m2) was significantly higher in Tanjona (16.69 ±4.3) compared to the 3 other sites (range of 5.2 - 8.2). Macro-invertebrate abundance (individuals/500m2) was found to be significantly higher in Nosy Antafana (825.8±918.7) compared to the

other three, with a minimal value at Tampolo (18.5±7.8). Overall, coral reef resilience indicators were higher for Tanjona, whereas Tampolo had the lowest values. In order to maintain the resilience of these marine parks, the park authorities undertook to update the conservation measures.

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MAIN SPECIES OF POCILLOPORIDAE (CNIDARIAN, SCLERACTINIAN) ON THE NOSY TAFARA REEFS, GREAT REEF OF TOLIARA, SOUTH-WESTERN REGION OF MADAGASCAR (Abstract ID: 28576 | Poster ID: 554)

A study on the Pocilloporidae family (Cnidarian, scleractinian) have been conducted on the reefs of Nosy Tafara (Southwest, Madagascar) from March, 2nd until Mai 4th, 2015. It aims to inventory as exhaustive as possible scleractinian to know the site's condition, stand characteristics, the coverage rate compared to other groups. Two stations were selected: Nosy Arakaivo on the platform of the outer slope between 10 to 15 m and Nosy Velomitahy, in a channel between 8 to 12 m deep. The method "Point Intercept Transect (PIT)" to 5 cm intervals placed along a line of 10 m, composed of 15 replicas were applied to each station. Fragments of species and / or colonies intercepted by the line were inventoried, sampled and photographed. Fragments of corals were collected and identified under a dissecting microscope. The results show the outer part of the reef Nosy Arakaivo has 75.20% of living coral. It is 70.20% for the reef Nosy Velomitahy. 16.17% of corals Nosy Arakaivo belong to the family of Pocilloporidae and 8.81% for the Nosy Velomitahy. 9/34 Pocilloporidae species identified throughout the Indo-Pacific region were surveyed, of which 7 species on the Nosy Arakaivo and 6 species on the Nosy Velomitahy. These species are divided into 3 genus: Pocillopora, Stylophora and Seriatopora.

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CRYPTIC CORAL REEF DIVERSITY AND FUNCTION ACROSS THE PACIFIC ASSESSED USING AUTONOMOUS REEF MONITORING STRUCTURES (ARMS) AND METAGENOMIC METHODS (Abstract ID: 29942)

Coral reefs provide essential habitats for rare, cryptic and symbiotic species that make up the vast majority of reef diversity. However, the complexity of reef habitats and lack of standardized measures are major obstacles in assessing these communities. As a result studies of the processes that drive biodiversity, ecosystem shifts and eukaryote-microbial associations have mostly relied on conspicuous species, e.g. corals and fish. Standardized 3-dimensional samplers (ARMS) mimicking the structural complexity of reefs were deployed at 60 sites across 5 environmental gradients in the Pacific. After 3 years living organisms were quantitatively extracted from these ARMS, each yielding 3 bulk-collected samples — sessile organisms and motile species of 2 size classes (100-500µm and 500µm - 2mm). Three amplicon libraries were constructed per sample for high-throughput sequencing: COI and 18S rRNA genes for Metazoans and the 16S rRNA gene for their associated bacteria. Metagenomic libraries were constructed at selected sites to examine microbial metabolism and changes in functional gene families across gradients of environmental impact and species composition. This data allows us to characterize cryptic Metazoan diversity across Pacific reefs and establish patterns of bacterial diversity, which clusters foremost by island chain. We investigate the fundamental links between Metazoan communities and their associated microbiota and between species diversity and ecosystem function at a time when understanding the effects of environmental shifts on marine ecosystems is paramount.

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THE FAST-GROWTH PROTOCOL: ACCELERATING CORAL GROWTH FOR REEF RESTORATION IN THE HAWAIIAN ARCHIPELAGO (Abstract ID: 28205)

Tropical coral reefs worldwide have a high economic and environmental value. Changes due to natural and anthropogenic factors have led to numerous reef restoration efforts. The success and scale of these projects have been highly variable. The majority of work has focused on in situ nurseries where larger colonies are fragmented and allowed to grow in a natural setting. This has shown promise where growth rates are high, but in Hawaii, calcification rates are amongst the slowest globally. We have developed a new strategy that utilizes an ex situ approach to accelerate the growth of common reef-building corals found around the Hawaiian Islands. We aim to mass produce fragments and modules in a nursery by manipulating variables including temperature, light, water chemistry, and heterotrophic food intake, while reducing sedimentation, disease, competition, and parasitism. Using this technique, coral fragments can rapidly grow at rates higher than those found in situ. These genetically-identical fragments will then be re-aggregated onto various forms to recreate single colonies via colony fusion and transplanted back onto impacted reefs. The result is larger corals that would have taken a decade or more to grow naturally, providing an effective method to restore Hawaiian reefs.

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CORAL DISEASES: TEASING OUT THE ROLE OF BACTERIA AND FUNGI (Abstract ID: 28169 | Poster ID: 144)

Coral reefs are rapidly declining due to increasing anthropogenic stressors and environmental changes. A major consequence of human pollution is coral diseases, the underlying pathological causes of which are mostly unknown. Most studies related to the holobiont and disease focus on bacteria, however, very few studies have investigated the role of fungi in compromised coral health. There are few studies on coral diseases in South China Sea. Vietnam's coral reefs experience rapid deterioration, which is easily observable in Central and Southern Vietnam (e.g. Nha Trang & Phu Quoc Island). Vietnam provides a good comparison of stressed and non-stressed areas with heavily developed cities compared to the Marine Protected Areas. This study aims to identify coral fungi and bacteria in stressed and non-stressed habitats in *Porites* spp., comparing the portfolios between different habitats in southern Vietnam, and identifying pathogenic bacterial and fungal growth in sick and healthy corals. The fungal and bacterial profile of the holobiont will be determined through metabarcoding with MISeq sequencing. Water samples were collected to provide a background of the microbes in the coral's environment. The results will provide identification of bacteria and fungi in corals within different stress regimes, and additionally, on a smaller scale, identify fungi and bacteria associated with disease. This is a step forward towards the understanding of the complex holobiont and drivers that influences the heath of the corals.

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IDENTIFYING COMMUNITY MANAGEMENT PRIORITIES USING PHOTOGRAPHY (Abstract ID: 29114)

Effective marine protected area (MPA) management requires the support of local communities. To achieve this, community concerns and knowledge must be understood and incorporated into management plans. Photovoices has developed a powerful tool to assess community priorities, which provides a way to hear villagers' unfiltered opinions and allows managers to learn from their expertise. We implemented this tool in a grassroots planning process in a highly touristed area on the east coast of Bali, Indonesia. Villagers in two communitities in the Regency of Karangasem were given cameras and encouraged to take photographs of any issues related to coral reef management. Trained facilitators gathered the stories behind the pictures, creating a visual and narrative compilation of local issues. Through this process, the community was able to identify three priority management areas: sedimentation, trash, and poor regulation of tourism activity. These key concerns are being incorporated into marine conservation strategies and management plans. The collection of information has been done by the community voluntarily, which has contributed to building a spirit of partnership within and between local communities that will foster collaborative co-management. We will present our approach, successes to date and lessons learned.

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HERBIVORE DISTRIBUTIONS MAY NOT ACCURATELY REFLECT HERBIVORY PATTERNS IN RECOVERING REEFS (Abstract ID: 28619 | Poster ID: 291)

As the uncertainties of a changing climate increasingly threaten the fate of coral reefs, understanding the inherent ability of reefs to recover from disturbances becomes critical. Herbivore fish populations are key drivers of reef resilience, mediating competition between coral and algae and promoting coral recruitment. However, herbivores represent a diverse assemblage,encompassing a range of feeding preferences, movement patterns

and behaviours; how these distribute across the reefscape can have important implications for reef recovery. Herbivores range widely, and their distribution can be highly variable in space and time, associated with different uses of the reefscape – for foraging, refuge, social interactions and others. We examined patterns of herbivore abundance and function in the Lakshadweep Archipelago, a few years after a coral mass mortality, to determine if their distribution between depths linked directly to herbivory rates at reefs. There was a strong relationship between abundance and herbivory in shallow reefs but not in intermediate and deep reefs, suggesting that herbivore distributions do not link completely with the distribution of ecosystem function. Behavioural observations showed that herbivores spent most of their time foraging in the shallows; in deeper reefs they were more than twice in density but spent most of the time skulking, potentially due to the availability of refuge which was extremely patchy in shallow reefs. Understanding how herbivores use the reefscape may be critical to determining their functional roles in recovering reefs.

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PHOTO PROTECTIVE EFFECT OF RU (II) AND CO (III) COMPOUNDS ON THE SYMBIOTIC ZOOXANTHELLAE ISOLATED FROM THE SEA ANEMONE STICHODACTYLA HADDONI (Abstract ID: 29185 | Poster ID: 496)

As a result of increasing threat to the survival of corals due to changing climate, efforts are being made to mitigate the effects of stress on corals and its symbionts. While increased seawater temperature results in coral bleaching, high irradiance effects the cellular mechanisms in zooxanthellae. In this study, zooxanthellae cells were treated with two photo-protective compounds to understand their effect on the ability of zooxanthelle to resist irradiance stress. we isolated and cultured zooxanthellae cells (clade C) form the sea anemone Stichodactyla haddoni. The cultures in log phase were treated with two photo-protective compounds namely, Ruthenium complex [Ru(bpy)2imbenzim](ClO4)2 and Cobalt complex [Co(bpy)2imbenzim](ClO4)3, where bpy is bipyridyl and imbenzim is imidazolylbenzimidazole ligand, at different concentrations (10, 50 and 100 µm l-1) and maintained under culture conditions for seven days. Results showed that the cultures treated with Ru (II) remained viable and the Co (III) treated cells showed cellular disruptions. Ru (II) complex treated cells exposed to high irradiance conditions (1000 µmol m-2s-1) showed that the cells treated with 10 µm l-1 and 50 µm l-1 concentrations were more viable and retained the photosynthetic pigments without any cellular damage compared to the control cells that were not treated with photo-protectant. The results of this study could have merit in terms of proactive conservation strategy of coelenterates such as corals that are frequently affected by the bleaching events.

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OLD WOUNDS TAKE LONG TO HEAL: SHIP GROUNDINGS AND CORAL DISEASE ON A PRISTINE CORAL REEF (Abstract ID: 28534)

The coral reefs of Tubbataha, Sulu Sea, are among the most pristine reefs remaining in the world, supporting 72% live coral and the highest fish biomass in the Philippines. In 2013, two ship groundings occurred within four months: the US minesweeper USS Guardian (USSG) on the South Atoll and the Chinese fishing vessel F/V Min Ping Yu (MPY) on the North Atoll. An estimated reef area of 6,248 m2 was critically damaged. In April 2015, we tested the hypothesis that physical damage to corals increased subsequent susceptibility to disease. We identified three zones associated with each grounding site: a "ground zero" zone of coral obliteration, where ships had pulverized underlying reef; a border zone on either side of ground zero where ship shifting caused additional damage to existing coral; and adjacent intact zones outside the footprint of ship impacts that served as control sites. 'Ground zero' zones had low coral density and recent recruits with little to no disease. Border zones had lower coral density than intact zones, but significantly higher prevalence of the coral disease white syndrome and chronic partial mortality (USSG WS: border zone=13.6%, control site=3.2%; partial mortality: border zone=33.7%, control site=7.4%; MPY WS: border zone=16.2%, control site=7.6%; partial mortality: border zone=27.8%, control site=16%). Our results suggest that, despite pristine reef condition, and high recruitment and herbivory, impacts of these physically destructive events extended beyond the immediate obliteration of coral and loss of reef structure, to persistent effects on coral health.
http://www.guammarinelab.com/raymundolab/

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AMERICAN SAMOA'S MARINE MANAGED AREAS: DESIGNING AND ASSESSING MARINE RESOURCE MANAGEMENT IN A MULTI-LEVEL GOVERNANCE SYSTEM (Abstract ID: 27770 | Poster ID: 639)

The U.S. territory of American Samoa has established a goal to protect 20% of its coral reef area under no-take MPAs as a primary marine conservation strategy. The territory implements MPAs through the use of diverse governance approaches, involving a range of institutions operating at different scales and including federal, territorial, and local village entities. This innovative approach to management takes advantage of the territory's traditional marine tenure system while drawing upon resources available from the U.S. federal government. Since 2000, total MPA coverage in American Samoa has expanded to encompass approximately 25% of coral reef area in the territory, with nearly 7% of reefs in no-take reserves. This represents a level of resource protection and inter-institutional collaboration that is unusual in the Pacific, and indeed worldwide. The innovative institutional arrangements developed to implement this system of MPAs present both unique challenges and opportunities in the management of the territory's marine resources. This paper represents the first comprehensive description and governance analysis of the MPA system in American Samoa, including the opportunities and challenges involved in combining Western management approaches with Samoan cultural institutions and tenure systems, compliance with and enforcement of village, territorial, and U.S. federal rules and regulations, interagency coordination and leadership, and consideration of scale in MPA planning, design, and implementation.

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EVALUATING THE EFFECTIVENESS OF THE AMERICAN SAMOA COMMUNITY-BASED FISHERIES MANAGEMENT PROGRAM (Abstract ID: 29002)

The Community-Based Fisheries Management Program of the American Samoan Department of Marine and Wildlife Resources was adapted from a Samoan model in 2005 in order to establish co-managed MPAs with communities throughout the territory. Ten communities are currently involved and they have requested assistance in improving their fisheries. In response, we designed a multi-phase process to assess management of CFMP sites based on published templates, the program's specific needs, and the available site specific information. Phase I focuses on reorganizing and enhancing record keeping and was carried out for several sites so far. Phase II was designed to further analyze site management in order to readdress social and ecological design and set realistic goals for the future. Both phases of assessments are presented in a score card format so that progress can be tracked over time, sites can be ranked, and management efforts can be prioritized. While the program successfully encourages coral reef management in American Samoa, our preliminary assessments point to major concerns for underutilization of available social and ecological data to drive the direction of management. Literature on MPA design and effectiveness suggests that only one CFMP MPA is likely to be large enough to protect commercially targeted fish. Seasonal openings of the majority of MPAs also raises concerns for their effectiveness in meeting fisheries related goals. In this presentation we discuss social complexities specific to American Samoa, lessons learned, and future directions for the CFMP program.

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SEASONAL PATTERNS OF GROWTH IN THE ROBUST BRANCHING CORAL ISOPORA PALIFERA FROM THE CENTRAL GREAT BARRIER REEF, AUSTRALIA (Abstract ID: 28526 | Poster ID: 234)

Studies on the growth response of corals to changing climate have largely focused on long-lived corals with relatively distinct density bands such as massive Porites. Little is known about the climatic response of other more abundant growth forms, such as branching Acropora corals, largely because of the absence of density bands. Using a combination of X-radiography, gamma-densitometry, Sr/Ca analysis and U-Th dating, we quantified growth patterns in the branching Isopora palifera from the central Great Barrier Reef, Australia. Visual analysis of positive X-radiographs revealed patterns of high-low density bands along the main growth axis, although gamma-densitometry was unable to detect a clear annual pattern in all samples. Skeletal Sr/Ca ratios consistently revealed clear patterns of seasonality matching local seawater temperatures, providing a growth chronology to calculate extension rates (averaging 2.07±0.09 cm yr-1). Using the Sr/Ca maxima, we were able to calculate annual density (1.57±0.03 g cm-3) and calcification rate (3.24±0.13 g cm-2 yr-1). Calibrations of monthly average SST and

monthly average coral Sr/Ca revealed a similar Sr/Ca-SST calibration for I. palifera to that of Porites from the same location, implying that the relationship between skeletal Sr/Ca and SST is highly robust among taxa, morphology, and growth rate. Our approach provides a robust method for assessing changes in growth for a common Indo-Pacific branching coral, and provides a valuable framework for quantifying past and future changes in skeletal growth in response to climate change.

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### SHIFTING THE MANAGEMENT PARADIGM AT RAINE ISLAND, THE WORLD'S LARGEST GREEN TURTLE ROOKERY – TO INTERVENE OR NOT TO INTERVENE? (Abstract ID: 29176)

Raine Island, a tiny cay in the northern Great Barrier Reef Marine Park, Australia, supports the largest aggregation of nesting green turtles in the world. There have been population studies on the nesting green turtles since the mid-1970s and this work has made significant contributions to informing our understanding and management of this species. However, studies in the late 1990s indicated that nesting and hatching success of the green turtles at Raine Island was very low when compared with other rookeries and that levels of adult mortality due to heat exhaustion, toppling over phosphate cliffs and getting caught in beachrock crevices were elevated. In order to improve the resilience of the nesting green turtle population at Raine Island, it was clear management agencies needed to do something to reverse the observed trends. Getting to the point where everyone agreed on intervention, however, was not a simple process. It required on-going effort and investment to overcome beliefs that these were natural processes and we should let nature take its course. Changing the management paradigm was assisted by targeted research and monitoring and by completing a resilience plan to identify those management actions we could take that would have the greatest benefit to the nesting green turtles. Ultimately, it came down to the management agencies being prepared to accept the risk of intervening; recognising that it would be difficult to make the situation much worse; to make decisions in the absence of perfect data and committing to and implementing a recovery plan for Raine Island.

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### EXAMINING PATTERNS OF BRACHYURAN CRAB DIVERSITY ACROSS US PACIFIC CORAL REEFS USING AUTONOMOUS REEF MONITORING STRUCTURES (Abstract ID: 29515 | Poster ID: 59)

Coral reefs are the most biologically diverse of all marine ecosystems. However, current understanding and assessment of reef systems is largely limited to the well-known and accessible biota, especially fishes and corals. The majority of reef diversity is comprised of small cryptic invertebrates living within its complex architecture. Autonomous Reef Monitoring Structures (ARMS) were developed as a systematic and standardized tool to assess and monitor the understudied cryptobiota. Here we examine the abundance, diversity and distribution of brachyuran crabs recovered from ARMS units deployed across the U.S. Pacific Islands and examine their assemblages across biogeographic, environmental, and anthropogenic gradients.

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### TEMPORAL VARIATION AND COMPARISON OF THE STATUS OF CORAL REEFS IN SELECTED SITES IN THE PHILIPPINES (Abstract ID: 28548)

This study investigates the temporal changes of the condition of coral reefs in two sites from three regions in the Philippines. Results showed a significant increase in coral cover in the southern side of Baladingan, Masbate from poor (14+4%) in 2009 to fair (28+3%) in 2015. Comparatively, coral cover in Guang-guang, Davao Oriental showed no significant difference despite the seeming increase from 27+10% in 2010 to 38+6% in 2015 while the northern side of Pujada I. experienced a decline from 75+3% to 49+7%. In Negros Oriental, a long-term study of Apo Chapel revealed a significantly increasing trend over a 17-year period from 19+8% in 1999 to 60+19% in 2005 and since then has remained in good condition for 11 years. This site also has the highest species diversity. No change was observed in Bantayan marine sanctuary for over 21 years with only 18+15% in 1995 to 24+8% in 2015. Comparison of current data between sites in each region showed statistically similar coral cover in Masbate and Davao Oriental. In Negros Oriental, Apo Chapel has significantly higher cover than Bantayan marine sanctuary. All sites exhibited good condition indices despite the low coral cover in some. Reef development was good in Apo Chapel and the sites in Davao Oriental. Poor reef development in Masbate and Bantayan was due to high abitoic-related components. Mortality indices were highest and species diversities lowest in Davao sites and Bantayan. Factors, i.e. level of protection, exposure to natural and anthropogenic disturbances and species composition influencing these changes are discussed.

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### FISHING WHAT'S LEFT: IMPACTS OF FISHING ON TROPHIC STRUCTURE OF REEF FISHES (Abstract ID: 29129)

Intensive fishing is believed to result in disequilibrium in ecosystem function with cascading impacts on the trophic structure of a marine system. Fishing tends to target large-sized top trophic level species due to size and market value. Fishery removal of large carnivores may result in increased abundance or biomass of lower trophic level species. In this study, we used information from underwater fish visual census and focus group discussions with fishers from over 20 localities across the Philippines to assess impacts of fishing on trophic structure of reef fishes and with emphasis on reef protection. Initial analyses show that density and biomass proportion of carnivorous species were relatively lower than herbivores in heavily fished sites, with few exceptions but represented by small-sized non-targeted carnivores, while the otherwise is observed in low fished areas or protected reefs. Density and biomass of fishery-targeted fish families were significantly low in heavily fished areas. Mean trophic level in these heavily identified sites have relatively low trophic index, suggesting that target fishes belong to small size class regardless of trophic level. High mean trophic level index in protected reefs suggest that no fishing preserve the interaction between trophic groups highlighting the need for management to conserve resources and sustain coral reef fisheries. The impacts of intensive fishery removal of biomass and the complex process of trophic interactions across larger spatial scale need to be investigated further.

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### THE IMPACT OF HETEROTROPHIC FEEDING ON THE PHYSIOLOGY OF THE CORAL HOST AND THE ASSOCIATED SYMBIONT UNDER DIFFERENT NUTRIENT ENRICHMENT CONDITIONS (Abstract ID: 28655)

Localised enrichment of dissolved inorganic nutrients are a considerable threat to coral reefs and have been associated with reduced diversity, abundance, and physiological tolerance. Past studies have often focussed on the influence of dissolved inorganic nutrients on the harboured zooxanthellae or the host coral, while the combined effects of heterotrophic feeding and dissolved inorganic nutrient uptake on the physiology of

both the host and symbiont remains understudied. To investigate these effects, we exposed corals associated with Symbiodinium sp. (clade C) to different levels of dissolved inorganic nitrogen (DIN) and phosphate (P). Specifically, we studied the response to low nutrient (low DIN: low P), nutrient replete (high DIN: high P), and imbalanced (high DIN: low P) conditions. After long-term acclimation to the different nutrient environments and feeding regimes, the density of Symbiodinium cells, their neutral lipid accumulation, and fluorescent host pigment content were measured as proxies of nutrient stress. Our results indicate a change in physiological condition of both the host coral and symbiont which may be exacerbated by feeding in nutrient enriched conditions, and could significantly impact on the functioning of the coral-alga symbiosis, and the resilience of the holobiont during temperature stress events.

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SYNTHESIZING GEOCHEMICAL AND GROWTH BANDING PROXIES FROM GREAT BARRIER REEF CORAL RECORDS (Abstract ID: 28894 | Poster ID: 8)

The growth response of reef-building corals to past environmental conditions is the subject of ongoing discussion, and could help researchers better anticipate the impacts of current climate change on reef health. In their skeletal banding, corals preserve a record of growth changes in response to past climate variability. Previous studies have used geochemical methods or growth banding analysis as coral paleoclimate proxies. However, few studies have combined these approaches, which would provide more comprehensive insight into the historical impact of environmental variability on coral growth. Our study combines geochemical analysis (δ18O, δ13C, and Sr/Ca) with luminescence and density measurements on five corals of the genus Porites from the Great Barrier Reef. These measurements track sea surface temperature, salinity, runoff, and coral growth at monthly resolution from ~1971 to 2008. The coral geochemistry tracks seasonal changes in climate, including temperature and precipitation, that vary with El Niño and La Niña events. These results allow us to evaluate the variable timing of density banding in relation to seasonal temperature extremes and highlight the role of location, such as proximity to rivers, in capturing a regionally representative climate signal. Our work establishes a methodology for multi-century coral paleoclimate records and demonstrates the value of combined datasets in coral climate reconstructions. These results lay the groundwork for much longer, paired reconstructions of climate and coral growth variability.

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RESILIENCE OF A UNIQUE MESOPHOTIC REEF IN THE GULF OF MEXICO, USA: A 30-YEAR HISTORICAL PERSPECTIVE OF THE CORAL COMMUNITIES AT PULLEY RIDGE REEF (Abstract ID: 28799)

A five-year study was funded by NOAA ("Connectivity of the Pulley Ridge - South Florida Coral Reef Ecosystem") to understand coral ecosystem connectivity in the southeastern United States, from mesophotic reefs at Pulley Ridge (PR) in the Gulf of Mexico to the shallow water reefs in the Florida Keys. This paper uses these data from ROV photographic transects over a four year period (2012-2015) to characterize the scleractinian coral community at Pulley Ridge mesophotic reef and to compare the coral community with historical surveys completed in 1980s and 2003. Our ROV surveys in 2012-15 document a biologically diverse and dense community dominated by algae (49% cover), diverse sponges (92 taxa), and hard corals (over 60,000 counted; e.g., Agaricia spp., Helioseris cucullata, Montastraea cavernosa, Madracis spp.). We discovered a catastrophic 93% loss of coral on main PR since 2003 (mean coral cover from 12.83% to 0.82%). However, in 2015 additional surveys discovered dense populations of argaricid corals outside of the PR Habitat Area of Particular Concern (HAPC) where average coral density was 18.46 colonies m^-2 (3.5% mean coral cover; max. 6.8%). Overall PR a relatively small percentage had signs of White Syndromes disease (mean 1.0%, max 4.04%) or bleaching (mean 0.76%, max 3.03%). Potential causes for the coral loss include cold water upwelling, hurricanes, disease, and river runoff. Kernel Smoothing Model in ArcGIS was used to plot the new coral distribution and was used in part to support a proposal to extend the boundaries of the PR HAPC.

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DO THE SHUFFLE: CHANGES IN SYMBIODINIUM CONSORTIA THROUGHOUT JUVENILE DEVELOPMENT (Abstract ID: 29636)

Previous studies of symbiotic associations between scleractinians corals and Symbiodium have demonstrated that hosts alter the consortium of symbionts in response to environmental conditions. However, less is known about symbiont shuffling during early development in corals, particularly for brooding species. This study examined whether Symbiodinium consortia varied (1) in Porites astreoides on shallow (10m) and upper mesophotic (30m) reefs, (2) changed during coral development and (3) influence growth of juveniles in different environments. Symbiodinium ITS2 sequences were amplified using universal primers and analyzed using phylotype-specific primers designed for phylotypes A, B, and C. Adults from both depths were found to host either only phylotype A, phylotypes A and B, or phylotypes A, B, and C and the frequency of the phylotype composition did not vary with depth. However, phylotype A was the dominant symbiont vertically transmitted to the planula. The presence of phylotypes B and C was detected in juveniles transplanted onto the shallow and upper mesophotic reef but not when juveniles were reared in outdoor aquaria. In addition, growth of juvenile P. astreoides harboring different combinations of Symbiodinium phylotypes did not vary. These results show that Symbiodinium consortia change during development and are influenced by environment.

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PROTECTING THE GREAT BARRIER REEF IN THE 21ST CENTURY: MANAGING COMPLEXITY AND RISK IN UNCERTAINTY (Abstract ID: 28948)

The greatest long-term risk to the Great Barrier Reef is global climate change. Regionally, the greatest policy challenge is to measure and respond to the many factors, in addition to climate change, which lower the resilience of the Great Barrier Reef and prevent its recovery from long-term decline in areas of highest pressure. While existing approaches to environmental impact assessment and marine spatial planning are providing positive protection benefits, they are insufficient. Many of the current pressures began last century and recent monitoring shows a resilient system, that while stable in some areas, is in long-term decline in others. Future environmental management will need new measures. At ecosystem scale, delivering conservation outcomes is not a linear set of steps taken by a few agents. The Authority and its partners will build a comprehensive monitoring and reporting system to inform on progress against the Reef 2050 Plan, and are now developing policies to guide future actions. These will redefine how activities are managed in the Reef region and guide responses to cumulative impacts. Building on a strong foundation of existing protection measures, new tools will include measures for: achieving reef recovery rather than halting decline; increasing knowledge of cumulative effects and building responses that are multi-sector and multi-jurisdictional; and increasing public awareness and knowledge of the factors affecting the Reef and options for building the Reef's resilience.

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EFFECTS OF MICROPLASTIC EXPOSURE ON GROWTH AND SURVIVAL RATES OF SCLERACTINIAN CORALS INFERRED WITH 3D SCANNING (Abstract ID: 28703)

Microplastics (i.e. fragments <5 mm) gained recent attention in public and science as they are considered to be a major threat to marine ecosystems. As these plastic particles are mainly of terrestrial origin, coastal ecosystems, such as coral reefs are particularly threatened. Previously it has been shown that scleractinian corals ingest microplastic particles. However, little is known about their subsequent effects on health and survival of the coral holobiont. Thus, the influence of microplastics (polyethylene, size 35 to 650 µm) on scleractinian corals (*Acropora*, *Pocillopora* and *Porites*) was examined in a series of fully controlled lab experiments. In particular, we studied the reactions of different coral species to particle contact. By the application of high-end 3D scanning and 3D model analyses coral growth was monitored. The species responded differently to microplastic exposure. Corals overgrew, took up and rejected plastic particles. Our preliminary results further indicate that microplastic exposure causes a decline in growth and

survival. We suggest that the exposure to microplastics leads to a reduction of energy reserves as handling of particles is energetically costly for the coral. Moreover, microscopical observations of the particles showed a strong bacterial load that can promote pathogen invasion. This is the first detailed monitoring of scleractinian corals from three different genera showing the adverse impacts of microplastic exposure, calling for further investigations of the effects of microplastics on the integrity of the coral holobiont.

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DIVERSITY OF SYMBIODINIUM SPP. IN THE ZOANTHARIAN ZOANTHUS SANSIBARICUS ACROSS VERTICAL GRADIENTS IN THE WESTERN PACIFIC (Abstract ID: 29819)

The zoantharian Zoanthus sansibaricus is widely distributed in the western Pacific from the intertidal zone to depths of more than 50 m. Research has indicated there is diversity in its association with endosymbiotic Symbiodinium spp., but fine-scale investigations across both depth gradients and geographic ranges are needed clarify the distribution of this diversity, as well as provide a basis for discussing the wide range of habitats and depths over which the host species thrives. In this study, we collected specimens from subtropical Okinawa, Japan, and tropical Palau, from the intertidal zone to >30 m. Molecular phylogenetic data from the non-coding region of the plastid mini-circle and other markers were contrasted between the primary locations, as well as a smaller set of samples from the Maldives, Hong Kong, and the Red Sea. In Okinawa, Z. sansibaricus in <5 m hosted two different species of Symbiodinium, while deeper colonies (>10 m) hosted another, different species, with transplant experiments suggesting no switching or shuffling between 'deep' and 'shallow' Symbiodinium. In Palau, shaded intertidal colonies in unique notch habitats hosted the same Symbiodinium as colonies from 20 m. Combined with population genetic data showing a lack of structure between host Z. sansibaricus populations across depth, these results suggest that 1) Z. sansibaricus has limited but important flexibility in its Symbiodinium associations, allowing it to exist in a variety of environments, and 2) the partitioning of Symbiodinium is driven primarily by micro-environmental light levels.
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NUTRIENT STIMULATION OF EXUDATES FROM DOMINANT CORAL REEF PRODUCERS AND IMPACTS ON MICROBIAL BIOFILMS (Abstract ID: 29789 | Poster ID: 139)

Shifts in reef benthic communities from calcifiers to fleshy algae have been documented on reefs worldwide. While it is well established that these phase-shifts have severe consequences for ecosystem services, the impacts of shifting benthic structure on reef microbial ecology is an area of active research because microbes recycle nutrients and are symbionts of corals. We hypothesized that differences in the dissolved organic matter (DOM) exudates of reef primary producers may determine the characteristics of conditioning films that provide the basis of marine biofilm formation necessary for larval settlement. We subjected four dominant benthic producers of tropical reefs – 1) corals, 2) macroalgae, 3) sediment-associated microphytobenthos and 4) rubble-encrusting algae (primarily CCA and turfs) - to two levels of nitrate and phosphate over several weeks. We characterized the community composition of biofilms using metagenomics and the composition of DOM using bulk elemental analysis and fluorescence spectroscopy. Dissolved organic carbon and nitrogen increased with nutrient enrichment on all substrate types; corals also exhibited increased organic concentrations in control (unenriched) treatments. DOM exudates from each substrate type were compositionally distinct from ambient water and enriched in fluorescent regions that indicate differential production of organic compounds by corals and algae in response to nutrients. Our results advance understanding of marine biofilm formation and organic production and consumption dynamics on reefs undergoing community shifts.

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ARE CORAL REEFS VICTIMS OF THEIR OWN PAST SUCCESS? (Abstract ID: 29241)

Sea-level fluctuations have been a driving force in community assembly of coastal ecosystems. For example, only ~20 thousand years ago all places where coral reefs grow today were emerged. In this talk we discuss the geological history of one of the most prolific reefbuilders in modern reefs, the staghorn corals. We demonstrate that these corals have a long and diverse history in the fossil record. The earliest representatives are of Paleocene age, and most of the present-day taxonomic groups were already present in the Late Miocene, long before the intensification of sea-level fluctuations as the result of the waxing and waning of continental glaciations. By evaluating the occurrence of staghorn coral dominated deposits in the geological record we demonstrate that even though the staghorn corals were highly diverse, they only contributed a small portion to the coral assemblages during the Miocene and Pliocene. Only following the onset of large-scale sea-level change in the early Pleistocene staghorn coral dominated units become abundant in both the Indo-Pacific and West Atlantic reef provinces. High growth rates and propagation by fragmentation has favored staghorn corals since this time. In contrast, staghorn corals are among the most vulnerable corals to anthropogenic stressors, with dramatic global loss of abundance worldwide. With continued decline in staghorn coral abundance, the mounting challenges from both local anthropogenic stress and climate change will limit the ability for coral reefs to provide ecosystem services.

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INTEGRATIVE ANALYSIS OF SUSTAINABLE TRAJECTORIES IN HEAVILY USED INDONESIAN CORAL REEF SYSTEMS (Abstract ID: 29555)

Many coral reefs in Indonesia are overexploited and heavily impacted by direct and indirect human use. The Spermonde Archipelago in the south-west of Sulawesi has about 70 small islands and is an example of such a heavily impacted system. The archipelago is situated off Makassar city, which, with its over 1.5 million inhabitants is an important regional centre for exporting sea products. Most of Spermonde's islands are densely populated. Fishing is the main source of income, and fishers employ over 20 gear types, targeting a wide range of species. Gear types differ in their impact on the reef ecosystem and in the social networks fishers work, either within the patron-client system which limits their decision-making options, or as more independent entrepreneurs. We will present an overview of a long-term, multi- and interdisciplinary approach to analyse the development of the Spermonde Archipelago reefs and focus on the drivers of system dynamics under multiple environmental and social conditions. Overall results show: a) the use of a wide variety of gears as well as the prevalence of destructive fishing methods, b) clear temporal changes in target species indicating changes in demand as well as in resource availability, and c) gradients in biotic community compositions and processes as well as physical conditions. Results are integrated into a spatially explicit simulation model and are holistically analysed in their feedback relations under multiple stressors to identify drivers of systems dynamics and pathways for sustainable marine resource management

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SURVIVAL AND GROWTH MONITORING OF TRANSPLANTED CORALS IN SPECIAL RESERVE, REPUBLIC OF SEYCHELLES (Abstract ID: 29305 | Poster ID: 481)

A large-scale coral reef restoration project was conducted in the Cousin Island, to recover coral loss due to massive bleaching from the 1998 El Nino-Indian Ocean Dipole event and coral breakage from the 2004 Indian Ocean tsunami. Using the "coral gardening" concept, first, we harvested coral fragments from donor colonies or corals of opportunity in nearby

areas and reared them in mid-water rope nurseries for about 1 to 2 years. Secondly, in March 2013 corals of which: Pocillopora grandis and Acropora cytherea were transplanted to the degraded reef site. We used a unique cement mix developed by C. Reveret and inspired by F. Seguin and the Creocean team. Briefly, Portland marine cement was mixed with sikacrete ® UCS. Sikacrete is a stabiliser powder that increases cohesion and reduces washout when cement is applied underwater. In March 2014, after allowing corals enough time to attach, a monitoring was initiated 1 year after transplantation ensuring that we are measuring the net growth rate. 35 colonies of each species were tagged in 2 plots (#6 and #7) distant of 20m at 9m depth. In April 2015 another monitoring was realised after 14 months. The survivorship of P. grandis is 100% in both plots and 87.5 and 57.1% for A. cytherea respectively in plot #6 and #7. A sand movement could however increase the mortality in plot 7. The change in ecological volume index using the formula as per Shafir et al. (2006) is: 64± 12% and 57± 14% for P. grandis respectively in plot #6 and #7. This outcome shows favorable results of survival rate with a transplantation with cement.
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BUTTERFLYFISH-MONOGENEAN INTERACTIONS: FROM BIOGEOGRAPHY TO ANALYSIS OF PARASITE SPECIFICITY THROUGH THE FISH MUCUS CHEMICAL FINGERPRINTS. (Abstract ID: 28653)

Interactions between hosts and parasites have been rarely studied in coral reefs and represent a major feature for the evolution, adaptation and ecology of interacting species. We studied the biogeography of gill monogenean parasites from 27 butterflyfish species in the South Pacific and our results show a conserved parasitism pattern over space, with clear differences between sympatric butterflyfish species. Among the 27 analyzed species, only Chaetodon lunulatus, was never parasitized. Although butterflyfish ecology has been extensively studied, parameters explaining parasite specificity between sympatric butterflyfish species are not well understood. Fish mucus is often described as the first line of defense against external attacks and several molecules with protective roles have been characterized. To study the possible chemical role in the specificity of monogeneans we studied the gill mucus of several butterflyfish species. First of all, we conducted an in vivo test and results showed that fish treated with C. lunulatus mucus displayed a decreased number of monogeneans. Then, we developed a non-targeted metabolomic approach to study the chemical fingerprint from gill mucus of several butterflyfish species with significant differences in their parasite loads. Results show differences in chemical composition between different Chaetodon species, but also between different ecological traits like diet and genetics. Finally, differences were found between parasitized and non-parasitized fish and further analysis are being performed to identify the responsible molecules.

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FLAVOBACTERIA-TURF ALGAE SYNERGISM (Abstract ID: 28821 | Poster ID: 138)

Coral reef degradation is often associated with overgrowth of ungrazed fleshy turf and macroalgae. While some mechanisms of microbially-mediated coral mortality at the coral-algal interface have been illustrated (e.g. hypoxia), less is known about how macroalgae and turf algae on the enrichment of specific coral pathogens. Recent studies demonstrate that turf algae foster specific copiotrophic guilds, including Alteromonadales and Flavobacteriales. Some species of Flavobacteria are known pathogens, causing a variety of well-documented marine fish diseases and are suggested to play a role in polymicrobial coral diseases such as Black Band, White Band, and White Plague. This study investigates the role of Flavobacteria in promoting a competitive advantage of turf over corals. Flavobacteria isolates were cultivated from turf algae enrichment cultures setup in Kaneohe Bay, Hawaii. The genomes of 15 different species of Flavobacteria were sequenced using the Illumina Miseq sequencing platform. These genomes are being annotated for the functional capacity to metabolize turf algal derived organic exudates, as well as genes involved in pathogenicity.

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LIMITED MORTALITY IN REEF CORALS OF THE GULF OF CALIFORNIA DURING THE 2015 EL NIÑO: EVIDENCE OF ADAPTATION? (Abstract ID: 30098 | Poster ID: 361)

A strong El Niño Southern Oscillation event affected the tropical eastern Pacific in 2015, causing sea temperature to rise above the coral bleaching threshold for several months. The objective of this study was to quantify the effect of the ENSO-induced warming in the Gulf of California, an area that was severely impacted by the 1987-88 and the 1997-98 events, when thermal anomalies were similar or even lower than those observed in 2015. We monitored four reef areas from July 2015 to January 2016, analyzing the status of over 200 tagged colonies and quantifying coral community structure in transects of 25 x 1 m. In addition, we surveyed over 20 locations in October 2015, to quantify bleaching at the peak of the event. Although historical records indicated that loss of coloration in years of excessive warming was noticed since August, actually the first damaged corals were seen until early October, and bleaching affected less than 30% of the colonies of Pocillopora and Porites. By January 2016 no discolored corals were observed, and comparisons of ecological indices between July and January showed no significant differences in any site. The delay in timing of the damage, the lower than expected incidence of bleached corals and the minimal mortality detected, indicates that reef corals in the southern Gulf of California are much more tolerant to excessively warm waters that they were in past decades. We suggest that repeated bleaching events, low population sizes, and high connectivity among populations, have served to facilitate adaptation of corals to thermal stress.

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ALTERING THE CALCIFYING FLUID STOICHIOMETRY INFLUENCES THE RATE AND MORPHOLOGY OF CALCIUM CARBONATE PRODUCTION (Abstract ID: 29362)

The calcifying fluid presents one of the most elusive areas of the calcifying processes among marine biota due to the often-impenetrable ability to measure the process *in situ*. Therefore, chemo-static growth experiments were conducted at fixed pH (8.7) and super-saturation ($omega^{aragonite}$ = 10), while varying the $Mg^{2+}$, $Ca^{2+}$, and carbonate stoichiometry. The $CaCO_3$ growth rate and crystal morphology is strongly depended on the solution stoichiometry. At a constant super-saturation, the growth rate was highest when the solution concentration ratio, r = $[Ca^{2+}]$/[carbonate], equalled 0.0625 (1:16) without $Mg^{2+}$, growth rate decreased when r = 1 without $Mg^{2+}$, and no difference was observed between the different stoichiometry of $Ca^{2+}$, and carbonate when various concentrations of $Mg^{2+}$ were incorporated. Corresponding to the stoichiometry a number of different $CaCO_3$ morphology were observed including rhomobohedral, elongated prism rhomobohedral, orthorhombic, laminate amorphous $CaCO_3$ (ACC) and cemented ACC.

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HOW CORAL REEF TRADE DATA CAN HELP INFORM POLICY DECISIONS (Abstract ID: 29519 | Poster ID: 696)

Recent ESA petitions have sparked intense debate within governments and the conservation community about industries that trade in these petitioned coral reef species. One of these industries is the marine aquarium trade, which has grown into a major global enterprise. Since the 1990s, the aquarium hobby has rapidly shifted focus from fish-only systems to miniature reef ecosystems. Millions of marine fishes and invertebrates, including corals, are removed from coral reefs and associated habitats each year for sale to home aquarists. Data collection for non-CITES-listed species is not mandatory and thus data are often nonexistent. Furthermore, CITES trade data are often confounded and/or confusing, and this lack of accurate and timely information about trade pathways, volume, and species diversity makes it nearly impossible to understand or to manage the trade sustainably, let alone inform the ESA petitions process. Here we examine the open-access Marine Aquarium Biodiversity and Trade Flow online database (https://www.aquariumtradedata.org/) for its ability to expand our knowledge and understanding of this trade and to effectively communicate this deepened understanding. We examine trade data for the Banggai cardinalfish (Pterapogon kauderni), the anemonefishes (Amphiprion ocellaris and A. percula), and the scleractinian corals, and we will show how trade data can be used to inform policy decisions and make management of traded coral reef species more effective for the conservation of species, and also for the well-being of communities that depend on this trade.
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STICKING AND SINKING: A MECHANISTIC APPROACH TO HOW CORAL GAMETES OFTEN LOSE AGAINST SEDIMENT EXPOSURE. (Abstract ID: 28318 | Poster ID: 431)

Sediments can impact the reproduction and developmental stages of coral and therefore threaten the resilience and recovery of reefs following disturbances. In a series of controlled experiments, we examined how suspended sediments typical of dredging operations may affect the ascent of coral egg-sperm bundles and impede fertilisation on the water's surface. We reveal that sediment grains can ballast and delay the ascent of egg-sperm bundles during spawning, and quantitatively model scenarios to predict the conditions that cause ballasting, and the subsequent reduction in egg-sperm encounter rates. Next, we reveal that successfully surfaced gametes are also threatened by sediment exposure due to sperm-limitation. Using multiple lines of evidence, we propose that the formation of sediment-sperm flocs is the primary mechanism responsible for a decrease in fertilisation success during sediment exposure, and detail the conditions that trigger this mechanism. This research forms part of a broader question of how sediments impact the early life history stages of corals and quantification of each of these interactions are improving our understanding of the risks that sediments from dredging, river plumes and resuspension pose, allowing for improved management around these events.

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PLASMA MEMBRANE PROTEOMIC RESPONSE OF THERMALLY STRESSED SYMBIODINIUM: IMPLICATIONS FOR SYMBIOSIS BREAKDOWN DURING BLEACHING (Abstract ID: 28775)

The endosymbiosis between corals and Symbiodinium range from resilient to fragile, with fragile partnerships often resulting in coral bleaching. Different factors affecting symbiosis have been extensively studied (increased temperatures, sedimentation, etc.) but the underlying mechanisms determining resilience deserve further attention. Because symbioses between the alga and host are initiated by cell-cell contact, extracellular membrane protein interactions between partners play important roles in recognition and downstream retention or rejection of the algal symbiont. Our overarching questions involve determining protein types present, what their possible roles in symbiotic mediation might be, and how these are affected by different stressors. We approach this by isolating cell surface membrane proteins using a membrane-impermeable biotin probe on intact cells and purifying the labeled proteins with avidin. These proteins are then tryptically digested and analyzed using nanospray LC-MS/MS. In Symbiodinium experimentally subjected to a 48-hour heat stress, preliminary results identify proteins containing important extracellular domains such as extracellular chaperones, recognition domains important for plant-Rhizobium symbioses, and domains known to participate in biogenesis of extracellular structural elements. Quantitative and qualitative changes in isolated proteins between heat-stressed and control samples will be presented, highlighting Symbiodinium changes that potentially affect communication between partners and providing further insight into symbiosis breakdown.

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HIGH CRYPTIC DIVERSITY, TAXONOMIC UNCERTAINTY AND THE RISK OF SILENT EXTINCTIONS IN CORALS (Abstract ID: 29247)

To prevent regional extinctions and potential losses of diversity and evolutionary novelty, accurate inventories of coral diversity assets must be established. For most Indo-Pacific coral communities taxonomic uncertainty is a recurring challenge that precludes the documentation of species trend data. Without this information, species are unlikely to be included on national threatened species lists even when they have been flagged as vulnerable or endangered at the global level. As a result, the combined absence of robust species delimitations, lack of demographic data and a shortfall of targeted conservation action at appropriate scales increases the risk that silent extinctions will occur. If globally threatened species were endemic to a particular country however, this could provide the necessary trigger for inclusion in national threatened species management plans, which would aid their conservation. Nevertheless, to date the overwhelming majority of Indo-Pacific corals are thought to occupy expansive, demographically linked geographic ranges and few are recognized as endemic to a single country. Here I will present new phylogeographic and phylogenomic data to demonstrate that extremely high levels of genetic divergence, indicative of cryptic speciation, occurs within several well-recognized and widespread 'species' of reef building coral. I aim to raise awareness about the implications of misunderstanding species boundaries and geographic ranges and discuss the opportunities for more efficacious conservation of coral diversity.

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STRUCTURAL COMPLEXITY MEDIATES FUNCTIONAL STRUCTURE OF REEF FISH ASSEMBLAGES AMONG CORAL HABITATS (Abstract ID: 27817)

Coral community composition is changing on coral reefs worldwide. Direct anthropogenic stressors and climate change have differential effects among coral species, causing increased dominance of more stress-resistant and/or weedy coral species. The extent to which altered composition of coral assemblages influences reef fish assemblages remains largely unknown. We investigate how the functional structure of fish assemblages varies among six distinct coral habitats. An ecological traits-based analysis was used to compare the functional richness, functional evenness, and functional divergence of fish assemblages among these coral habitats. Our results reveal differences in the functional richness and functional divergence, but not functional evenness, of fish assemblages, with structural complexity of coral habitats being the best predictor of these differences. Fish assemblages in branching *Porites* habitat were functionally richer than those in*Pocillopora* and soft coral habitats, largely due to the presence of nocturnally active, schooling cardinalfishes in the branching *Porites* habitat. Massive and branching *Porites* habitats displayed greater functional divergence in fish assemblages than *Pocillopora* habitats because of a greater abundance of small, schooling planktivores which were rare or absent on lower complexity *Pocillopora* habitats. Our results indicate that coral composition may act as a habitat filter, affecting the distribution and abundance of associated species traits, particularly those of small-bodied schooling fishes.

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USING MOLECULAR TOOLS TO DIAGNOSE AND TREAT THE CAUSES OF CORAL REEF DECLINE (Abstract ID: 28226)

Coral reefs throughout the world are exposed to multiple stressors from local and global sources. Tools for the assessment and monitoring of coral reefs have been good for measuring losses or gains in percent cover and species diversity, with mortality as the key indicator of stress. In order to effectively address problems prior to outright mortality, better health indicators are needed that can measure changes at the cellular and organismal levels, rather than at the community or ecosystem levels and with response times of weeks to months rather than years to decades. Protein expression in corals can detect stress responses at the sublethal level, when intervention can yield the most promising results. Coupled with genetic information, effects at the population level can also be determined and evaluated. Analyses of coral tissue samples collected from three areas in Hawaii, Honokowai, Wahikuli (west Maui) and Maunalua Bay, Oahu, demonstrate the value of molecular tools in identifying stress exposure qualitatively and quantitatively and in providing a framework for assessing the effectiveness of mitigation activities. The data demonstrate that both adaptation and selection are occurring on these reefs, and raise the concern that while species of corals may persist, genetic diversity is being lost, and hence, so is population resilience to changes in stress profiles. Molecular tools provide data, which can help in the proper allocation of limited human, financial and institutional resources to enhance the ability of corals and coral reefs to persist and thrive.

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CHANGES IN FISH WARINESS ACROSS A GRADIENT OF INTENSITY IN SCUBA DIVING ACTIVITY (Abstract ID: 28408)

Human recreational activities like hiking can elicit anti-predator responses in prey species that are similar in nature and magnitude to those elicited by hunting, sometimes triggering dramatic shifts in the surrounding ecosystem via behaviorally mediated cascades. Studies that test analogous hypotheses about the effects of recreational activities in marine systems are rare, but provide evidence that SCUBA diving activities elicit anti-predator behavior in some marine fish. While exposure to spear fishing activity has been correlated to increased wariness in coral reef fish even inside areas that are protected from fishing, the effects of different chronic levels of intensity in SCUBA diving on reef fish behavior remains virtually untested. We measured the wariness of herbivorous coral reef fish to recreational diver presence and approaches across a gradient of chronic intensity in diver activity surrounding Little Cayman Island, where spear fishing is prohibited and SCUBA diving tourism is popular. We compared the flight initiation distances (FID) and changes in pre-flight behavior of reef fish among sites with different historical levels of tourist visitation to determine the impact of different levels of intensity in recreational diving on the behavior of reef fish. We discuss the applicability of our results to the management of recreational activities on coral reefs, which currently assume negligible impacts from SCUBA diving activities, and potential interactions between fishing and recreational diving effects in coral reef systems worldwide.

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DISTURBANCE DYNAMICS AND MARGINAL REEF CORAL POPULATIONS (Abstract ID: 28095)

Marginal coral reefs are controlled by frequent disturbances that lead to a progressive "weeding out" of otherwise dominant taxa capable of reef-building. Empirical observations and models have shown that the structure of marginal, non-accreting reefs is environmentally-controlled either via repetitive mass mortality or sub-optimal environmental conditions stunting coral growth. This controls the local species pool and does not allow competitive networks to reach climax. Using stage-based models it is shown how coral population dynamics relates to disturbance frequency and how variable disturbance and connectivity can control persistence or disappearance. At least some marginal reefs show signs of high local recruitment, which facilitates phase-shifts away from corals after multiple, severe disturbances that disrupt inflow of larvae. Naturally high and, with climate change, increasing disturbance-frequencies primarily skew size-distributions towards the smaller classes, which opens space for potential competitors (corals, algae or other organisms) and reduces fecundity exponentially. Shift in size classes, community composition and competition can rapidly lead to changes in stability patterns with the emergence of alternate states by acting alone or in concert. Steepness of thresholds and mechanisms determines whether alternate states are reached via bifurcations and are relatively stable, or gradually and are reversible. Examples of marginal or pauci-specific coral systems from all oceans are examined.

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SKELETAL GROWTH TRENDS OF TWO MASSIVE REEF-BUILDING CORALS ON THE FLORIDA REEF TRACT: ARE INSHORE CORALS BETTER OFF IN A WARMING OCEAN? (Abstract ID: 28785)

Through the slow, continuous growth of their calcium carbonate skeletons, corals record invaluable information about past environmental conditions and how they may affect colony fitness. As the warming global climate continues to threaten coral reefs throughout the tropics, these living archives can be used to help identify reefs that are particularly susceptible or resilient to environmental change. Mounting evidence suggests that nearshore corals may be better suited than their forereef counterparts to cope with warming ocean temperatures due to their acclimatization to highly variable thermal environments. To test this hypothesis, we compared skeletal growth records of inshore and offshore reef corals across ~200 km of the Florida Reef Tract using cores extracted from two widespread massive reef-building coral species, *Siderastrea siderea* and *Pseudodiploria strigosa*. In 2015-2016, ten cores of each species were extracted from four sets of paired inshore-offshore reef sites spanning the entire reef tract, and growth parameters were assessed using 3-D computerized tomography. Skeletal extension rates were estimated from the thickness of high- and low-density annual growth couplets and were combined with density measurements to yield calcification rate. This century-scale investigation of inshore-offshore differences in coral growth will provide critical insights into our understanding of how corals on the Florida Reef Tract are likely to respond to future climate change scenarios.

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ACROPORA CERVICORNIS SPAWNING PROJECT: A PARTNERSHIP ACROSS ORGANIZATIONS PROVIDING ADDITIONAL SOLUTIONS TO REEF RECOVERY (Abstract ID: 30015 | Poster ID: 681)

Once abundant throughout the Florida Keys and Caribbean, Acropora cervicornis populations have drastically declined due to a variety of natural and anthropogenic stressors. Colonies still in existence are sparsely distributed only intensifying the issue of reef decline by inhibiting the successful fertilization or recruitment of new coral individuals. To increase A. cervicornis individuals on degraded reefs, restoration programs can outplant colonies growing in offshore nurseries to designated restoration sites. The manpower required to restore reefs to their previous state, may become a limiting factor in the amount of coral that can be outplanted. The integration of spawning processes may generate more effective coral restoration practices to enhance population sizes and facilitate the natural recovery of A. cervicornis. In 2010, an A. cervicornis spawning project was commenced by The Florida Aquarium, Coral Restoration Foundation, and University of Florida. Since its inception, the project has grown to include over 5 additional partners that meet annually for the predicted Caribbean Acropora spawn. Methods for the tracking of egg development, creation of spawning structures, efficient settlement materials, and tanks for grow out have all been developed from this project, building a foundation to expand upon for future applications to restoration programs. This project is a superlative demonstration of collaboration across organizations for the advancement of solutions for reef recovery, in excess of what any individual partner could have achieved working alone.

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PROCESSES DRIVING CORAL RESILIENCE TO BLEACHING (Abstract ID: 29511)

Coral bleaching is increasing in frequency and extent on reefs around the world. Although these events are predicted to become more frequent with climate change, our understanding of the factors that drive resistance to and recovery from bleaching is incomplete. The last documented coral bleaching in Hawai'i was 1996, but in the summers of both 2014 and 2015 corals throughout Hawai'i experienced extensive bleaching. On Oahu, field surveys in both year showed that reefs in Kaneohe Bay experienced 40-80% bleaching. Species diversity surveys showed that *Pocillopora* spp. were the most susceptible and *Leptastraea purpurea* was extremely resistant in both years of bleaching. In October 2014, 150 coral colonies were tagged and monitored monthly to assess recovery from bleaching. *Porites compressa*and *Pocillopora damicornis* appeared fully recovered three months after the peak summer temperatures, but *Montipora capitata* had significantly slower recovery. Only three colonies of *Montipora capitata* and three colonies of*Pocillopora damicornis* died from bleaching during the two years of monitoring. Some corals remained unbleached through both events, suggesting adaptation or acclimatization to thermal stress. There is a pressing need to understand coral genetic and physiological mechanisms of thermal tolerance in these corals to better manage for reef resilience in the face of climate change.

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LA PLATA ISLAND ECUADOR: REFUGE OF CORAL RESELIENCE (Abstract ID: 30121 | Poster ID: 55)

La Plata Island located in the Machalilla National Park, Ecuador, is perhaps one of the southernmost refuge of corals in the eastern Pacific. Its rich marine diversity represents a source of income for the local fisheries and tourism. This study presents an overview of the distribution, species richness and percent coral cover at La Plata Island. Macroinvertebrates and reef fishes are also reported as fauna associated to the coral formations. Twenty species of corals, one hundred and fifty-one species of fishes and thirty three species of macro invertebrates are registered. The massive Pavona clavus is the dominant species in La Plata, with coral formations of 6 m high. The two genus Pavona and Psammocora have the broadest depth range distribution from 1.5m to 15 m. The Pocillopora species are more common in shallow waters, especially P.meandrina and P. ligulata, not exceeding 5 m depth. The human impact is latent in the reef; nylon lines tangled in coral colonies, plastic trash, tourists articles and discarded fishing gear. Nevertheless, coral colonies maintain good health. The results of this study suggests that the island of La Plata has resilient coral formations, capable to resist the two strong El Niño events 1982/83 and 1997/98.
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MOLECULAR PHYLOGENY OF THE CARIBBEAN SCLERACTINIAN CORALS: SOLVING THE PUZZLE (Abstract ID: 29836 | Poster ID: 33)

Scleractinian corals are the main reef-building organisms in both tropical and cold-water coral reefs. Paradoxically, complete phylogenetic analyses are lacking for all coral species in provinces as small as the Caribbean. These analyses constitute a powerful tool for defining systematics, taxonomy and relationships among different species, but when it comes to scleractinian corals, clear relationships have not been clearly established. The

paucity of studies for phylogenetic analysis in this group can be explained by the lack of DNA sequences with enough phylogenetic signal for most scleractinian genera. This study aimed to establish the most complete molecular phylogeny for Caribbean scleractinian corals using ITS2 sequences for 41 coral species, which have been corrected using their predicted RNA secondary structure. Secondary structures allow generating enhanced tree topologies. On the other hand, we assessed the divergence times on the ITS2-based phylogeny, in order to determine the approximate age of the taxa studied. Results show that, as it has been suggested before, the Scleractinia class divides into two major clades (robust and complex), but it also showed some differences. One of the most important results is the sister relationship between Leptoseris cucullata and Agaricia grahamae, which has not been reported before for Caribbean scleractinian corals, as well as likely new species in this clade. The clustering in the Agariciidae family helps to understand how this group can be potentially indivisible, suggesting a recent adaptive radiation in the Caribbean.

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FEAST AND FAMINE: A STRATEGY FOR SURVIVING OCEAN WARMING (Abstract ID: 29820)

Enhanced warming of the central tropical Pacific is projected over the next decades, and efforts are underway to identify reefs that might survive this change. Stress bands, anomalously high density bands seen in skeletal cores of massive reef-building corals can provide insights into the persistence and variability of bleaching events across space and time. We tested the connection between stress band formation in Porites corals, the intensity of thermal stress and the scale of bleaching using both laboratory manipulation experiments and in situ field observations. Results provided a framework to interpret stress bands in corals from the remote island of Jarvis, central equatorial Pacific, in the absence of direct historical observations of bleaching. At Jarvis, stress bands appear consistently during strong El Nino events back to the early 1900's, indicating that Jarvis may have bleached regularly over the last century, yet maintains exceptionally high biomass and percent live coral cover. We visited Jarvis in November 2015 and observed bleaching across multiple taxa including Porites. Still, the majority of colonies were alive, after 30+ weeks of anomalies 1-3.5 C. A comparison of coral tissue thickness between non-El Nino and El Nino years suggests that bleached corals may be living off substantial energetic reserves accumulated during periods when ocean productivity is high. Whether this "feast and famine" strategy for surviving El Nino-induced thermal stress can carry corals through the unprecedented 2015 warming will be revealed in a return expedition in May 2016.

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MANAGING AND PROTECTING CORAL REEFS THROUGH PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT'S PERMIT PROGRAM (Abstract ID: 27901 | Poster ID: 680)

Access and activities within marine protected areas (MPAs) typically are regulated by a permit system to manage and mitigate human impacts to resources. While some MPAs are managed by a single agency responsible for reviewing and issuing permits, Papahānaumokuākea Marine National Monument ("PMNM" or "Monument") has a multi-agency co-management structure. PMNM's joint permit program serves as the primary regulatory tool for how co-managing partners effectively manage and protect coral reef resources. Through PMNM's permit system managers have worked together to authorize essential studies for understanding coral reef ecosystems as well as activities aimed to protect corals. Additionally, through the Monument's permit program, co-managing partners have collaboratively developed various protocols to protect coral reefs as both natural and cultural resources. These include vessel hull inspections for alien invasive species and best management practices. From a native Hawaiian perspective, corals (and all natural resources) are considered cultural resources. All permitted individuals are required to attend a cultural briefing to learn about the significance of these resources to native Hawaiians and are encouraged to approach research activities with this perspective. This case-study explores the origins and evolution of PMNM's permit program, and how it has and continues to contribute to coral reef management and protection.

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EXPERIENTIAL COURSES FOR HIGH SCHOOL STUDENTS AT THE HAWAII INSTITUTE OF MARINE BIOLOGY (Abstract ID: 29958 | Poster ID: 718)

Sustainable interactions between coastal communities and the marine environment begin with public education and the sharing of knowledge in marine science. At the Hawai'i Institute of Marine Biology (HIMB), inquiry-based summer courses are offered to high school youth with the objective of creating educational pathways for future scientists, managers, and stewards by increasing science and environmental literacy skills. Each summer, HIMB enrolls Hawai'i high school students in the Research Experiences in Marine Science (REMS) Program, as well as hosts students from around the world in the Science in Action (SiA) Program, both held at Moku o Lo'e in Kāne'ohe Bay. Post-baccalaureate interns, graduate students, high school science teachers, and UH faculty and staff develop and prepare lessons that include field and laboratory exercises in diverse disciplines such as coral reef monitoring, computer data processing, squid neuroethology, sea urchin spawning and fertilization, marine bioacoustics, fish larval development, and ocean acidification. For REMS, the course also includes an extended unit dedicated towards the development, execution, and presentation of original group research projects. Students work in small teams to plan an experimental design, complete field data collection, analyze data with statistical tests, and offer a formal presentation of their projects through a scientific paper and symposium talk. Student assessments and program evaluations show improvements in science literacy skills, including in the use of the scientific method and investigation.

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DEMOGRAPHIC DYNAMICS OF THE COMMON DEMOSPONGE IRCINIA FELIX (Abstract ID: 30092)

Sponges are one of the principal benthic components of Caribbean coral reefs. Despite the fact that they have multiple functional roles, little is known about their demography and ecology. Here, we present a demographic study of the common demosponge Ircinia felix performed at Tamarindo Bay, Culebra, Puerto Rico. Preliminary studies comparing size structure of two populations within Tamarindo Bay, Tamarindo North (TN) and Tamarindo South (TS), indicate that sponges at TN are significantly larger than sponges at TS. These data served as baseline for the present comparative study in which we aim to determine whether such spatial differences in population size structure can be explained by differences in rates of survival, growth, and/or recruitment. Significant differences where only observed when comparing growth rates. The fact that rates of survival and recruitment where similar between localities may be the causal factor for the lack of significant difference in population growth rates ($\lambda$) which varied TN and TS (0.79 and 0.74, respectively). Interestingly, elasticity analyses suggest that the major contributor to $\lambda$ at TN was survival of large sponges whereas at TS survival of small individuals contributed the most; suggesting that I. felix is able to adapt to site-specific environmental conditions by means of life history traits plasticity. We are currently conducting a study to determine if the noticeably high presence of gorgonians in TN in comparison to TS may be responsible for site-specific growth rates.

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CORAL BLEACHING IN TELA, HONDURAS AND THE MESOAMERICAN REEF REGION (Abstract ID: 29058)

The third global coral bleaching episode began affecting reefs worldwide in summer 2015. This study presents the first recorded bleaching event in a high coral cover reef system (≤69%) in Tela Bay, Honduras observed in September-November, 2015. This area is also exposed to high sedimentation, turbidity and nutrient inputs from ten bodies of water. To estimate bleaching, corals were originally surveyed using the AGRRA protocol and further evaluated with the bar drop method, which assesses a minimum of 150 colonies per site in shallow (5-7m) and deep sites (9-14m). Sea temperature (T°C) was obtained *in situ* using loggers from mid July to December and compared to satellite data (1km). A bleaching severity scale (normal, pale, partially bleached, bleached-over 80%) and percent mortality (new, transitory and old) was assessed in 6 sites. Preliminary results show that the most abundant and affected corals are *Undaria tenuifolia*, *Porites astreoides*and *Siderastrea siderea*, with primarily paling, partial bleaching and low mortality. The overall conditions of surveyed colonies were pale (43%), partially bleached (35%), normal (18%), and fully bleached (5%). The average T showed sept-nov as the hottest months (30.8°C) with a drop of 1.39°C in December. This study is included in a regional evaluation of 65 sites throughout the Mesoamerican Reef, as part of the Coral Bleaching

Emergency Response monitoring plan led by the Healthy Reefs Initiative and 19 partner organizations. Overall, bleaching status in the MAR region will also be presented. http://www.agrra.org

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ANTIOXIDANT DEFENSE AND ACID-BASE REGULATION: PHYSIOLOGICAL TOLERANCE AND ACCLIMATIZATION TO OCEAN ACIDIFICATION AND WARMING IN POCILLOPORA DAMICORNIS (Abstract ID: 29667)

Given the rapid pace of global ocean acidification and warming, methods by which corals can use their existing physiological repertoire to tolerate changing environmental conditions may provide insight into their potential for acclimatization and longer-term persistence. Ocean acidification and warming may interact to challenge larval physiology through increased production of reactive oxygen species and modification of homeostatic intracellular pH. To examine physiological plasticity under this multi-stressor scenario, larvae of *Pocillopora damicornis* were exposed to levels of temperature and $pCO_2$ after which antioxidant defense and acid-base maintenance were assessed. Planulae had higher total antioxidant potential at High-$pCO_2$ than under ambient conditions, and planulae released at the peak of spawning had a greater response than those released two days later. Activity of catalase, an antioxidant enzyme was also measured. Partial activity of $Na^+/K^+$-ATPase did not differ significantly between treatments. One of the first examples of oxidative stress response and acid-base regulation in coral larvae, short-term plasticity of antioxidant defense in coral larvae may be an important mechanism underlying acclimatization to ocean acidification and warming.

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DIFFERENTIAL RECYCLING OF CORAL- AND ALGAL-DERIVED DISSOLVED ORGANIC MATTER BY CORAL REEF SPONGES (Abstract ID: 28784)

Sponges are proposed to play a key role in the recycling of energy and nutrients on coral reefs by rapidly taking up dissolved organic matter (DOM) and transferring it as particulate detritus to higher trophic levels via the recently discovered sponge loop pathway. Corals and macroalgae release large quantities of DOM that, due to differences in quality and composition, exert differing effects on reef ecosystem functioning. However, the influence of various reef DOM sources on recycling via the sponge loop has not been investigated. Here we used stable isotope pulse-chase experiments to compare the processing of coral- and algal-derived DOM by three Red Sea reef sponges: Chondrilla sacciformis, Hemimycale arabica, and Mycale fistulifera. All three species assimilated both DOM sources, but incorporation rates were higher for algal-derived DOM. The two DOM sources were also differentially utilized by the sponge holobiont (i.e. sponge host + associated microbes). While algal-derived DOM was incorporated more into bacteria-specific phospholipid fatty acids (PLFAs), coral-derived DOM was preferentially incorporated into PLFAs specific to the sponge host. A substantial fraction of the DOM assimilated by the sponges was subsequently released as detritus, but again, algal-derived DOM was released at a higher rate. The more rapid uptake and transformation rates of algal- compared with coral-derived DOM suggests that reef community phase-shifts from coral to algal dominance may stimulate DOM cycling through the sponge loop with potential consequences for reef biogeochemical cycles.

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CORAL MUCUS FUELS THE SPONGE LOOP IN WARM- AND COLD-WATER CORAL REEF ECOSYSTEMS (Abstract ID: 28777)

Scleractinian corals engineer the framework of shallow warm-water (WW) and deep-sea cold-water (CW) coral reefs and control biogeochemical cycles by releasing coral mucus in the form of particulate and dissolved organic matter (DOM). Caribbean reef sponges transform DOM into particulate detritus, thereby controlling the transfer of energy and nutrients in DOM up the reef food web via the recently discovered sponge loop. Thus, the dissolved fraction of released coral mucus may represent an important DOM source fuelling the sponge loop. We investigated the transfer of coral mucus into tissue components of the WW sponges *Mycale fistulifera* and*Negombata magnifica*, and the CW sponge *Hymedesmia coriacea* using lab-based stable isotope tracer experiments. Results revealed a direct trophic link between scleractinian corals and reef sponges, and showed that 21–40% of assimilated coral mucus C and 32–39% of N was transformed and released as particulate detritus. Follow-up experiments demonstrated the consumption of WW sponge detritus by sponge-associated detritivores, the ophiuroids *Ophiothrix savignyi* and *Ophiocoma scolopendrina*, and the polychaete *Polydorella smurovi*, thereby showing the transfer of sponge detritus to higher trophic levels. These findings of a coral mucus-fuelled sponge loop in ecosystems as different as WW and CW reefs provide evidence for its ubiquitous functional role in contributing to the efficient biogeochemical cycling of limiting nutrients and energy in these highly productive marine environments.

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EFFECTS OF SEDIMENTATION ON SCLERACTINIAN CORAL SPECIES COMPOSITION ALONG A RIVER GRADIENT IN MACAJALAR BAY, NORTHERN MINDANAO, PHILIPPINES (Abstract ID: 29336 | Poster ID: 224)

Coral survival is dependent on several factors and sedimentation is one factor that can affect all others. Macajalar Bay in Misamis Oriental is a major fishing ground for 14 municipalities and 2 cities. There are three major rivers that empty into the bay bringing different kinds of river run-off that can affect biological, geological, physical and chemical processes. Eight sites were chosen (2 controls and 6 impacted) where the sediment accumulation rate varied for each site throughout the year (this included wet and dry seasons). Also notable was the difference in sediment characteristics, where control sites had mostly sand but the sites nearest to the river mouth were mostly silt. However some sites displayed a trend in different sediment accumulations through the wet and dry seasons. Coral assemblages also varied in colony sizes, life-forms, but most species were found in all sites.

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THE POWER OF MICROBES: MICROBIAL BIOENERGETICS OF CORAL-ALGAL INTERACTIONS (Abstract ID: 28922 | Poster ID: 104)

The once steady-states of coral reef ecosystems are transitioning to algal-dominated states on a global scale. Thermodynamic theory predicts that as these systems undergo transition they will optimize their components to maximize power output. Thus, we hypothesize that perturbed areas far from steady-state such as the coral-algal interface will harbor microbial communities optimized to maximize their thermodynamic power output. To test this hypothesis, we used a novel combination of methods to provide a bioenergetic analysis of interaction zones. This study reveals that the energetic demands of microbial communities at the coral-algal interaction interface are higher than in the communities associated with either of the single organisms. This is evident through a) higher microbial power output, and b) lower oxygen concentration at interaction zones compared to areas distal from the interface. Increase in microbial power output is significantly correlated with the ratio of heterotrophic to autotrophic microbes but not microbial cell abundance. Finally, microbial metagenomes generated from coral-algal interactions suggest that a shift from efficient glycolytic pathways towards faster, less efficient alternative catabolic pathways is responsible for the change in power output.

Together these data suggest that coral-algal interfaces harbor higher proportions of heterotrophic microbes that are optimized to maximize the power output, as opposed to yield. This yield to power shift provides a thermodynamic mechanism underlying the global microbialization of coral reefs.

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REVISITING DEPTH-DIVERSITY GRADIENTS IN REEF-BUILDING CORALS (Abstract ID: 28264)

Species are not distributed evenly across geographical space, and understanding the mechanisms generating species' distributions is a fundamental goal of ecology. Among the most prominent of these patterns are changes in species richness over gradients (e.g. latitude, altitude, or depth). Depth is a strong environmental gradient on coral reefs, with depth zonation recognized as a ubiquitous feature of coral ecosystems. However, depth ranges of reef-building corals at any particular site are influenced by a combination of factors (e.g. turbidity, latitude). Species richness is considered to either decline with depth, or peak at intermediate depths (15-35 m), mirroring altitudinal richness gradients in terrestrial ecosystems. Understanding depth-diversity patterns is a crucial component of revealing how species occupy ecological and geographical space. However, robust analyses of depth-diversity relationships have been compromised by a chronic under-sampling of deeper habitats (> 20 m), and considerable changes in coral nomenclature in recent decades. As such, the generality of this pattern is questionable. Here, we use modern statistical techniques and a novel comprehensive, species-level data set conducted over a large depth gradient (0-45 m) to revisit fundamental questions about depth-diversity relationships in reef-building corals. We show how species richness changes over depth, and identify ecological traits associated with coral depth ranges. Our results provide new insights into ecological factors influencing depth ranges and depth-diversity relationships in corals.

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THE ANTIOXIDANT RESPONSES DIFFER BETWEEN *SYMBIODINIUM* STRAINS FROM DIFFERENT GEOGRAPHIC ORIGINS (Abstract ID: 28310)

Studies conducted these last two decades have revealed that high sea surface temperatures accompanied by high levels of solar irradiance are responsible for an over production of reactive oxygen species (ROS) leading to the disruption of the symbiosis between cnidarians and their symbiotic *Symbiodinium*. But, all coral species do not show the same sensitivity to stress. In this context we examined how the antioxidant network of different *Symbiodinium* species responds to oxidative stress. We bypassed the various thermal and light tolerances existing among the genus *Symbiodinium* by using a chemical approach (menadione). ROS produced during this oxidative burst reduced photosynthesis by 30 to 50% and significantly decreased the activity of superoxide dismutase. In addition, the low level of lipid peroxidation concomitantly with the decrease in the concentration of diatoxanthin and other carotenoids during the stress confirms their function of antioxidants and their role in the stabilization of membrane lipids. The analysis of the cellular damages also indicates that proteins were damaged and most likely eliminated by the ubiquitin-proteasome pathway. Finally, caspase-like activity decreased suggesting that cell death mechanisms are not initiated at the early stage of the stress. Although, the mechanisms at play seem to be the same, we found that the temperate *Symbiodinium* strain (A1) was less impacted by the treatment with menadione than the tropical strain (F1) suggesting that the variations observed are related to their geographic origin.

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HOST IMMUNE SYSTEM POLYMORPHISM AND GENE EXPRESSION IN HOST-SYMBIONT RELATIONSHIPS (Abstract ID: 28816 | Poster ID: 140)

Across domains of life, immune system components display the highest rates of adaptive evolution and maintained polymorphisms. Within holobionts, population, local or individual-level host polymorphism and expression of immune system components allow flexible interactions and adaptive immune response to symbionts while potentially driving holobiont microbiota. To investigate immune system variation and immunity related gene-expression and to assess the role that these components might play in holobiont composition, metatranscriptomes and metagenomes were constructed from Porites spp holobionts from sites across the Southern Line Islands in the Central Pacific. Replicate samples were collected within individual coral colonies across multiple colonies at site and island scales. Individual coral genotypes across multiple loci were derived from transcriptomes and used to identify loci under selection. Polymorphism and heterozygozity for immune system components at the island and patch level are examined to test for heterozygote advantage and disruptive or balancing selection. Metagenomes are used to survey virulence factors or immunity-related genes within holobiont microbial communities. Target loci include putative epithelial attached mucin-like glycoproteins important in a range of host-symbiont specific interactions. Correlations between symbiont genes and host immune system gene expression at the intracolony to intercolony levels reveal potential host-symbiont gene by gene interaction and suggests mechanisms for host-bacteria interactions that drive holobiont composition.

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SIZE-SELECTIVE FISHING OF CORAL REEF FISH COMMUNITIES (Abstract ID: 29604)

Coral reef ecosystems are a vital food resource for millions of people. Although the negative effect of fishing on total fish biomass is well documented, our understanding of the impacts of human disturbance on fish community structure is limited to studies at local scales. We analysed an extensive dataset of reef fish community body sizes collected at 38 Pacific islands and atolls to examine how reef fish community size structure and total community biomass varied across two metrics of anthropogenic disturbance and eight environmental covariates. Our results revealed that the slopes of fish community size spectra steepened with increasing human population density and proximity to provincial capital, consistent with a reduction in the biomass of large-bodied fish. Total reef fish biomass was substantially depleted even at low levels of human presence, though oceanic productivity and sea surface temperature were also important drivers. Our results indicate that across multi-gear, multi-species fisheries, exploitation of reef fish communities is size-selective. Furthermore, we observed substantial natural variation in reef fish biomass that suggests biomass-based management strategies may be difficult to implement across large spatial scales. In contrast, impacts on community size structure were consistent across diverse reef communities. Traditional fisheries concepts such as size spectrum indicators may help to develop successful approaches to the sustainable management of coral reef systems.
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RECRUITMENT PATTERNS OF CORAL REEF FISHES IN THE CENTRAL RED SEA: DIFFERENCES ACCORDING TO SEASON AND REEF TYPE (Abstract ID: 28664)

The Red Sea is the world's northernmost tropical sea. The latitudinal extent of its deep, narrow basin and its limited connection to the world's oceanic system make for a unique environment with extreme temperature and salinity regimes. Yet the Red Sea harbors one of the largest and most biodiverse coral reef systems in our planet. In order to better understand the impact of these unique environmental conditions on the biology of coral reef fishes, a year-long light trap study was conducted on three reefs in the central Red Sea—one inshore, one midshore and one offshore—in order to quantify seasonal timing, biomass and biodiversity of incoming reef fish recruits. Collection took place during every new moon for five consecutive nights to capture seasonal variation in recruitment at different reef types and habitats. The mitochondrial cytochrome oxidase I (COI) region was used to identify the trapped recruits. To date, very little is known about annual reproductive peaks in this region. This dataset will provide a useful guide for identification of recruits of coral reef fishes, and will increase the number of genetic barcodes available for coral reef fishes.

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PRODUCTIVITY AND SEA SURFACE TEMPERATURE CORRELATE WITH PELAGIC LARVAL DURATIONS OF DAMSELFISHES IN THE RED SEA (Abstract ID: 28911)

To date, nearly 60% of all marine studies in the Red Sea have taken place in the northernmost region, the Gulf of Aqaba. However, temperature, salinity, and nutrients gradually change from north to south, locally shaping coral reef fish communities and

populations of the Red Sea. We examined the influence of this environmental gradient in the Red Sea on the pelagic larval durations (PLDs) of three damselfishes, *Dascyllus aruanus*, *D. marginatus*, and *D. trimaculatus*. PLDs were significantly correlated with latitude, sea surface temperature (SST), and primary production (CHLA; chlorophyll *a*concentrations). Among all three species, we find a consistent decrease in PLDs with increasing SST and primary production (CHLA) towards the southern Red Sea. This trend is likely related to higher food availability and increased metabolic rates in that region. We suggest that food availability is a potentially stronger driver of variation in PLD than temperature, especially in highly oligotrophic regions. Additionally, variations in PLDs were particularly high among specimens of *D. marginatus*, suggesting a stronger response to local environmental differences for endemic species. We also report the first average PLD for this species over a broad geographic range (19.82 ± 2.92 days).

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TRADE-OFFS AND VARIATION IN INSHORE CORAL HEALTH AND BIOCHEMICAL CONDITION ALONG WATER QUALITY GRADIENTS ON THE GREAT BARRIER REEF, AUSTRALIA (Abstract ID: 29353)

Biochemical attributes of corals can be used as indicators to monitor spatio-temporal changes in their health and condition. This study explores how a coral species (*Acropora tenuis*) can respond to differing water quality conditions on inshore reefs of the central Great Barrier Reef. Coral health was monitored along a strong and a weak water quality gradient, each with three reefs at increasing distances from a major river mouth. Significant differences in coral health traits were detected along the strong water quality gradient: corals grew fastest, had the least dense skeletons, highest symbiont densities, and highest tissue energetic content closest to the river mouth. Changes in coral health traits were far weaker along the second, much weaker, water quality gradient. This variation in health traits along water quality gradients illustrates that corals acclimatize and/or adapt to their surrounding environments. Our data indicate that high nutrient and particulate loads are not detrimental for the survival of this robust coral species, but the observed biochemical changes are not without potential consequence, including higher susceptibility to photo-stressors and physical damage. Our study provides insights into spatio-temporal changes of coral health indicators, the influence of water quality driving coral condition, and adds valuable data for integrated monitoring of coral reefs.

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USE OF INTEGRATED LANDSCAPE INDICATORS TO EVALUATE THE CONDITION OF "RIDGE TO REEF" SYSTEMS AND PRIORITIZE WATERSHEDS FOR RESTORATION IN THE HAWAIIAN ISLANDS. (Abstract ID: 27798)

The ahupua'a concept, a linkage between the condition of watersheds and adjacent nearshore coral reef communities is an assumed paradigm in the concept of integrated coastal management. We present quantitative evidence for this "ridge to reef" relationship on a large-scale comparing the Hawai'i Watershed Health Index (HI-WHI) and Reef Health Index (HI-RHI). A significant positive relationship is shown between the health of watersheds and adjacent reef environments when all sites and depths are considered. This relationship is strongest for shallow sites facing in a southerly direction, but diminishes for north facing coasts exposed to persistent high surf that increase local wave driven currents and flush watershed-derived materials away from nearshore waters. Candidate metrics for assessing reef condition were tested against independent measures of human disturbance to define biocriteria. Prioritization of watersheds and coastal waters are being developed for protection and restoration in Hawai'i. This study facilitates an understanding of the interaction between ecological processes, spatial patterns, and human activity which can be applied to improve regional-scale conservation and resource management.

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A TOOLKIT FOR MANAGING RIVER INPUTS TO CORAL REEFS (Abstract ID: 28357 | Poster ID: 443)

Recent biogeochemical studies have shown that the health of nearshore coral reefs can be directly impacted by land use practices in the adjacent terrestrial environment. Rivers often facilitate the transportation of excess nutrients, sediments, and other pollutants, resulting in both acute and chronic impacts to corals. Although the conduits of delivery are understood, establishing riverine pollutant thresholds that directly impact coral reef health, has remained elusive. This is largely due to the lack of real-time sampling connecting both environments and archival sampling that links historical land use with original stress to reefs. Here we present a progress report of our multi-tiered approach towards developing a toolkit consisting of step-wise decision tree models and a management guide. To date, we have begun to (1) quantify watershed pollutant concentrations to discern the threshold for acute stress on coral health; (2) identify point source impacts and mitigation success of existing riparian buffers; (3) link historical land use practices with marine samples; (4) develop a bibliographic library/ historical archive for Guánica related to watershed and oceanographic studies; and (5) train the next generation of resource scientists and managers.

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ENHANCING THE ACQUISITION OF DATA FOR REEF SCIENCE AND MANAGEMENT: CONTRIBUTIONS FROM THE XL CATLIN SEAVIEW SURVEY (Abstract ID: 30013)

Restraining the global decline of coral reefs requires effective actions from managers, policy-makers and society as a whole. Reef scientists are challenged with the complex task of promptly providing relevant inputs for science-based decision-making. The XL Catlin Seaview Survey (CSS) is applying pioneering technologies for producing broad-scale baseline data of coral reefs worldwide. The CSS framework involves three key components: photographic surveys, image analysis and provision of information. So far, the CSS has surveyed ~650 shallow transects (10-12 m), each 1-2 km in length, using customized underwater vehicles for collecting high-definition images. Over 1000 km of reef habitats have been recorded and more than 650,000 geo-referenced images are being automatically annotated to optimise data acquisition. Validation of this approach indicates most benthic categories can be estimated with errors below 4 %. Images are in an open-access repository (www.globalreefrecord.org) and core data is progressively accessible. The CSS is making available an unprecedented source of reliable data to support spatial and structural analyses, mapping, monitoring and ecological modelling. Further, the CSS research has assessed recent disturbance events (e.g. cyclones and bleaching) and is addressing a range of ecological questions with direct implications for coral reef management. Enabling healthy reef systems is crucial for sustainability, therefore the translation of such scientific outputs into meaningful information for managers and policy-makers warrants serious attention.

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EFFECT OF ABNORMAL HIGH TEMPERATURES DURING 2014-2015 ON CORAL COMMUNITIES FROM CENTRAL MEXICAN PACIFIC (Abstract ID: 27883)

Central Mexican Pacific coral communities have suffered severe bleaching events related to high temperatures with evidence of slow but constant recovery. Abnormal increases in temperature during 2014 and El Niño 2015 have severely affected to the coral com-

munities of this region, as well. Differential coral bleaching were registered at two insular National Parks, Islas Marietas and Isla Isabel, with a distance of 100 km between them. Differences on bleaching response were observed between Islands. During 2014 sea surface temperature (SST) reached a maximum of 31.9°C; mortalities were registered only at Isabel Island (~99% coral cover). During El Niño 2015 SST reached 32.7°C, impacting Islas Marietas with a bleaching of 90% of coral cover. with a high recovery rate by the end of the year and a mortality of only 2%. No recovery has been registered on coral coverage at Isla Isabel. The species that were most affected during both events were massive ones, such as Pavona and Porites , surprisingly Pocillopora has demonstrated the highest degree of tolerance. The different responses of the species distributed at the same region, demonstrate the differential acclimatization capacity acquired by the corals, product of several episodes of stress conditions, which has been different due to the location and the particular physical processes at each site. Coral community at Marietas can be considered as highly resistant to ENSO events; this acclimatization will be one of the primary characteristics that, will allow the species to maintain the coral community from this region

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MICROSCOPICAL DIFFERENTIATION BETWEEN REGENERATION AND DEGENERATION OF TISSUES IN POCILLOPORA (Abstract ID: 28450)

Tissue loss is a lesion affecting many coral species and is an important cause of coral reef decline in the Western Atlantic. Causes of tissue loss may be infectious or non-infectious (trauma). As such, not all tissue loss processes are invariably fatal to coral colonies, and some colonies can recover. Tissue regeneration is a fundamental process to the normal functioning of corals. Knowing the tissue characteristics of wound repair could help differentiate degenerative from regenerative processes in coral disease. To those ends, we compared histology of wound repair in dominant Pocillopora in Mexico with experimentally induced tissue loss (trauma) to naturally occurring tissue loss of unknown origin in wild corals. Tissues in experimentally traumatized corals healed within 30 days but remained unpigmented through day 40. Histologically, completely healed tissues were evident at the edge of the lesion from Day 8 and onwards when the lesion site was microscopically indistinguishable from adjacent normal tissues. Pocillopora manifested a unique mode of regeneration involving projections of cell-covered mesoglea from the upper body wall that anastomosed to form gastrovascular canals. Samples of wild corals with tissue loss of undefined origin presented characteristics associated with degeneration such as necrosis and hypertrophy of epithelia with no microscopic evidence of tissue regeneration as seen in experimental corals thereby proving the utility of histology to aid interpretation of lesion pathogenesis in corals.

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GEOMORPHIC ZONATION AND CORAL TYPE MAPS FOR THE GREAT BARRIER REEF (GBR): A MAPPING AND MODELLING APPROACH APPLIED IN THE CAPRICORN BUNKER GROUP (Abstract ID: 29071)

The Great Barrier Reef (GBR) is a globally unique and essential national resource for Australia; however no single map exists showing its geomorphic zonation and benthic community composition. These maps have not been produced for the GBR due to its large extent and the cost of mapping its extensive and mostly submerged reefs. This presentation introduces a new approach to map geomorphic and coral community zonation for the "shallow offshore reefs", and validate the results, for a large reef system of the Capricorn Bunker Group in the GBR. These "shallow offshore reefs" are visible in optical remote sensing imagery to depths of 20 m. This approach to mapping and modelling of geomorphic and coral community zones combines: field data; Landsat 8 derived reflectance and bathymetry data (15 m x 15 m pixel size); cyclone track data; slope, wave exposure; object based image analysis and models for predicting the spatial distribution of GBR coral communities. The mapping and validation methods are being developed for future application to the whole of the GBR. This larger scale approach will include existing field data collection programs (e.g. Long Time Monitoring Program), citizen science groups (e.g. Reef Check, Eye on The Reef), and, crowd sourcing of other field data and interpretations (e.g. GeoWiki). The methods and digital maps represent a significant advance in our capability to map, monitor and manage coral reefs in Australia, supporting management and science in the conservation of the Great Barrier Reef, and, are applicable to other reefs globally.

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PHASE SHIFT DYNAMICS FOLLOWING CATASTROPHIC DISTURBANCE ON AN INDO-PACIFIC CORAL REEF SYSTEM (PALAU, WESTERN PACIFIC) (Abstract ID: 28857)

In December 2012, a Category 5 super typhoon passed 50 km south of Palau (Micronesia), causing a catastrophic loss of coral cover. Within weeks following the disturbance, we observed a rapid and extensive phase shift of the macroalgae Liagora sp. Comparisons between pre and post-disturbance surveys indicated that relative changes in herbivore biomass and coral cover did not significantly predict the extent of macroalgal cover. In contrast, wave exposure explained >90% of model variance, indicating that environmental conditions play an important role in post-disturbance dynamics. Settlement tiles deployed during the major spawning period (March – April 2013) following the typhoon revealed that reefs that had undergone phase shifts experienced an near complete failure of coral settlement, despite no limitation in larval supply. While the Liagora bloom had started to decline by April 2013, we observed succession to a second macroalgae (Lobophora variegata). Experimental manipulations and cage exclusion revealed that Liagora canopies acted as ecological facilitators, providing a 'nursery' exclusion zone from the impact of herbivorous fish, allowing for the establishment of understory Lobophora. While the ephemeral Liagora bloom had disappeared entirely 9 months post-typhoon, the facilitated phase shift to Lobophora has persisted for over 18 months, dominating ~40 % of the reef substrate. Collectively, these results provide novel insight into post-disturbance dynamics on Indo-Pacific reefs, and indicate that typhoons may also trigger rather than reverse phase shifts.

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GEOCHEMICAL AND CRYSTALLOGRAPHIC STUDY OF *TRIDACNA MAXIMA* (MOLLUSCA: BIVALVIA) SPECIMENS AFFECTED BY THE 2010-2011 WESTERN AUSTRALIAN MARINE HEAT WAVE (Abstract ID: 29183 | Poster ID: 288)

*Tridacna maxima* shells are complex $CaCO_3$ micro-laminated structures that record physiological and environmental changes during growth as sequential chemical and crystallographic variations in the shells. The organic fraction, crucial to shell integrity, is also to be considered when studying records of environmental changes. In this study we highlight the relationships between shell proteins, chemical composition, crystal morphology and crystal orientation through geochemical and crystallographic characterisation of three specimens of *Tridacna maxima*from Ningaloo Reef, Western Australia. This multi-modal imaging and analytical approach uses X-ray diffractometry, Raman spectroscopy, electron probe micro-analysis, laser-ablation ICP-MS and stable isotopic analysis to constrain the relationships between shell microstructure and composition and physiological and environmental changes. These specimens show evidence of scaring and survived the marine heat wave off the Western Australian coast over the 2010-2011 summer. Water temperatures rose to unprecedented levels (over 3DegC above monthly average) causing lethal to sub-lethal effects with short- and long-term impacts on the ecosystem. Symbiotic organisms such as corals and *Tridacna* are known to bleach heavily under thermal stress, with coral bleaching recorded from Rottnest Island (near Perth) to Cygnet Bay (northern Kimberley region) in 2011. The nano- to micro scale effects of bleaching on *Tridacna* are also being investigated using a geochemical and crystallographic approach.

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THE INFLUENCE OF STRUCTURAL COMPLEXITY ON CORAL REEF PRODUCTIVITY (Abstract ID: 28040)

In response to multiple stressors, live coral cover and habitat structural complexity are declining on coral reefs across the globe. These changes can influence trophic interactions and energy flows within the reef community and have consequences for ecosys-

tem services such as fish production. We have developed a size-based food web model for coral reefs that explicitly incorporates the influence of habitat structural complexity, benthic primary production, and detrital recycling on ecosystem dynamics. We use the model to explore how fish production might change in the future in response to ongoing and anticipated alterations to reef habitats. We show that, with all else being equal, a loss of reef structural complexity may result in a 3-fold reduction in fish production. However, as live coral cover declines, potential increases in the abundance and availability of algal turfs and mobile invertebrates may have positive effects on food web productivity. We explore this potential trade-off between refuge availability and resource availability through time, in the context of a changing reef state. We show how things may get better before they get worse, but also that the complexity of reef habitats must be maintained in the long-term to ensure that coral reefs can continue to provide enough food for our ever increasing human population.

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DYNAMIC SPONGE DEFENSE SYSTEMS AGAINST PREDATOR AND PATHOGEN ATTACKS (Abstract ID: 27954)

Sponges and other sessile invertebrates are under constant attack by predators and pathogens. At the same time, they are lacking behavioural escape or defense mechanisms and rely therefore on morphological or chemical defenses. Sponges are a known source of a vast array of chemical metabolites, even though the metabolic costs of metabolite production and their ecological functions remain mostly unknown. We investigated whether tropical sponge species optimize their chemical weaponry by inducing defenses in response to artificial predation, or whether wounding triggers a activated defense. Additionally, we tested if these mechanisms are simultaneously used to boost antimicrobial activity to avoid bacterial infection. Laboratory experiments with eight pacific sponge species showed that 87% of the tested species were chemically defended. Two species, Stylissa massa and Melophlus sarasinorum, induced defenses in response to simulated predation, which was the first demonstration of induced antipredatory defenses in marine sponges. One species, M. sarasinorum, also showed activated defense in response to wounding. Interestingly, 50% of the tested sponge species demonstrated induced antimicrobial defense. Simulated predation increased the antimicrobial defenses in Aplysinella sp., Cacospongia sp., M. sarasinorum, and S. massa. Our results suggest that some sponges further increase their defensive effectiveness by induced and activated defenses and that these modifications boost antimicrobial activity. Predation seems to select for induced antimicrobial defenses to protect sponges from pathogens that could otherwise invade the sponge tissue via feeding scars.

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UNRAVELLING COMPLIANCE DYNAMICS WITHIN LOCALLY MANAGED MARINE AREAS IN SOLOMON ISLANDS AND FIJI (Abstract ID: 28358)

Diverse socio-economic developments, population pressure as well as deficient legal mandates are increasingly challenging customary marine governance approaches in Melanesia. Compliance with and enforcement of local management strategies (such as temporal and spatial closures) constitute a growing hurdle for communities - impacting decisively on the success or failure of these local marine tenure practices. Understanding drivers of (non-) compliance can inform future management decisions as well as the design and implementation of local marine tenure rules. We have examined compliance dynamics within locally managed marine areas in Solomon Islands and Fiji. We find that perceptions of limited legitimacy of rules and of rule-makers, linked to questions about the recognition and justification of power, represent a major constraint for compliance. Using the concept of the 'enforcement chain' (detection, arrest/citation, prosecution and conviction) we analyze how social, institutional, financial and legal barriers (e.g. interpretation of customary fishing rights, weakening power of traditional leadership, poor enforcement structures and monitoring tools as well as limited legal mandates) impede the different links of the chain. In this paper we also discuss the interplay between customary and state law regarding compliance by assessing how existing (customary and state) rules and norms (dis-)connect or add up. Finally, we make suggestions that can strengthen enforcement and compliance with marine tenure rules, thus helping to maximize positive social-ecological outcomes.

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PREDICTING REEF FUTURES VIA BIOPHYSICAL CHARACTERS OF HOLOBIONTS AND INTERACTION ZONES (Abstract ID: 27861)

Benthic holobionts (i.e., macrobe host with its associated viruses and microbes) engage in a constant war for space. Corals and CCAs holobionts win on healthy, calcifying reefs. Overfishing and nutrification, as well as thermal and other stressors, increasingly favor turf and fleshy macroalgae holobionts leading to microbialization and degradation of the reef structure. In earlier work, we showed that the relative abundance of interaction zones between corals and algae increases with reef degradation. Building on this observation, we hypothesized that coral-to-algal dominance switches are geometrically driven by an exponential decrease in coral surface area relative to a linear change in the perimeter that must be defended from encroachment. This hypothesis is being tested using a combination of metagenomics, metatranscriptomics, metabolomics, advanced imaging and modeling of the main reef holobionts and their interaction zones. Analysis of hundreds of samples from the Pacific and Caribbean are pinpointing viral, microbial, chemical and physical characters that predict and explain the health trajectory of benthic holobionts. Together these data provide both statistical and mechanical explanations for why coral reefs live and die.

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THE BENEFITS OF LONG TERM COMMUNITY-BASED CATCH MONITORING PROGRAM FOR ADAPTIVE AND SUSTAINABLE FISHERIES DEVELOPMENT (Abstract ID: 28228)

The Philippines is a multi-gear, multi-fishery country that is largely dependent on fish protein for both diet and livelihood. Over the last three decades fishery laws and management strategies have been enacted and put in place at both national and local levels to attempt to develop sustainable fisheries. These laws and strategies include fisheries closure through establishment of Marine Protected Areas, closed and open seasons for commercially valuable species, fisher and boat registration, gear regulations and coastal enforcement policies. While a combination of tools are used to assess and validate the effectiveness of these policies and strategies, effectiveness is usually only assessed once and is not monitored over time. We hypothesize that local policies and management strategies would benefit from a long-term catch monitoring program to determine the effectiveness of both legislation and management strategies. Only via long-term monitoring can the variability in fisheries and behavioral change in fishers be assessed. Here, we reintroduce a long-term fish catch monitoring system in four pilot sites in the Philippines to obtain information on Catch Per Unit Effort [CPUE] and length-weight relationships of commercially valuable species. We discuss the processes in setting up a community-based catch monitoring system, the lessons learned in applying data, issues with limited assessment tools and the benefits of the results in evaluating current management strategies. We conclude that a comprehensive community-based catch monitoring program can bring fishers, fisheries experts, policy makers and managers together for participatory and adaptive management options.

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REPRODUCTIVE PHENOLOGY ALTERS FUNCTIONAL CONNECTIVITY FOR CORALS IN THE EASTERN TROPICAL PACIFIC (Abstract ID: 29563)

In the Eastern Tropical Pacific (ETP), the reproductive phenology of corals remains largely undetermined. Here, we used long-term mean sea surface temperature (SST) and found four thermal regimes in the ETP: Tropical Upwelling, Thermally Stable, Equatorial Upwelling, and Seasonal regime. We conducted a meta-analysis of both the reproductive phenology (month of spawning) and dispersal-related traits. We correlated the SST with the month of spawning, and inferred the impact of reproductive strategies and dispersal traits on the region's functional connectivity. We found a correlation between the SST and the spawning occurrences. Asynchronic spawning occurred irregularly throughout the year in the Upwelling and Thermally Stable regimes. Spawning had a strong seasonal signal in the warm months in the Equatorial Upwelling and Seasonal regimes. Reproductive and dispersal-related traits strongly suggested a reliance on self-seeding for population persistence. In contrast, nearly half of the corals produced autotrophic larvae, a trait favouring LDD. Despite the diversity of reproductive strategies and dispersal traits, coral populations in the ETP are more reproductively isolated, more dependent on self-seeding, and more vulnerable to disturbance than previously considered. Furthermore, the tight coupling between spawning and sea surface temperature suggests an increased susceptibility of coral assemblages to El Niño events and ocean warming scenarios.

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FUNCTIONAL CONNECTIVITY OF CORALS ACROSS THE EASTERN TROPICAL PACIFIC (Abstract ID: 29564)

Because of the reduced size and isolation of reefs in the Eastern Tropical Pacific (ETP), long-distance dispersal (LDD) is considered a key process that influences their ecologi-

cal dynamics. Here, we used a biophysical dispersal model to examine the functional connectivity of corals between regions in the Central Tropical Pacific (CTP) and the ETP. The connectivity simulation included an ocean circulation model, the coral's potential habitat, and their reproductive and larval-related traits. We simulated 470 spawning events from 1993–2012, exploring larval durations of up to a maximum of 150-days. We found a very low probability of connectivity from the CTP to the ETP (0.01). Larvae cross the eastern pacific barrier (EPB) along the North Equatorial Counter Current, using the Clipperton Atoll as a stepping-stone. The Clipperton Atoll appears to act as a potential larval source for nearly all the regions of the ETP. There also appears to be a possible east-to-west dispersal pathway from the Galapagos Islands to Marquesas and Line Islands. Crossing the EPB is not possible with larval durations less than 50 days. Our results suggest that transpacific LDD is possible, though likely infrequent, in the ecological time-scale for these corals. Lastly, the Clipperton Atoll and Cocos Islands may serve as key stepping-stones and as central nodes within the ETP reef MPA network.

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CORALS AND THE U.S. ENDANGERED SPECIES ACT: BRIDGING THE GAP BETWEEN SCIENCE, MANAGEMENT, AND CONSERVATION ACTION (Abstract ID: 29786 | Poster ID: 699)

Coral reefs are among the most biodiverse ecosystems on earth and are important sources of goods and services, yet they are being increasingly degraded, in particular from ocean warming and acidification. In response to a petition citing this degradation, in 2014 the National Marine Fisheries Service (NMFS) published a final rule listing 20 coral species, 5 from the Caribbean and 15 from the Indo-Pacific, as threatened under the U.S. Endangered Species Act (ESA). In contrast to the Caribbean, very little is known about the distribution of the listed species in U.S. waters in the Pacific. Moreover, disagreement exists among taxonomic experts on the identification of some of the species, confounding efforts to better determine their distributions and the habitats critical to their survival. However, the ESA mandates that Federal agencies or applicants requiring Federal permits for activities in coral reef ecosystem waters consult with NMFS in an effort to avoid and minimize their activity's impacts on listed species. In the absence of reliable information on the distribution of listed species, maps are being developed to show the distribution of all scleractinian corals, and the location of hard substrates they may recruit to. Using the best available data, maps are being developed for the islands of American Samoa, Guam, the Northern Mariana Islands, and the U.S. Pacific Remote Islands to facilitate management of listed species. Data and methods being used for mapping, as well as challenges and limitations of this effort will be discussed. http://www.pifsc.noaa.gov/cred/ecospatial_information.php

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SOCIO-ECONOMIC ASSESSMENT TOOL (SEAT): ASSESSING THE SOCIO-ECONOMIC BENEFITS OF MARINE PROTECTED AREAS (MPAS) (Abstract ID: 30003 | Poster ID: 644)

The Socio-Economic Assessment Tool (SEAT) is a set of indicators meant to measure the effectiveness of Marine Protected Areas (MPAs) in delivering socio-economic benefits to local communities in the MPA's immediate vicinity. MPAs have been scientifically proven to enhance the earth's natural capital in the marine ecosystem. SEAT attempts to validate the claim that such an enhancement directly contributes to improved human wellbeing. The ultimate goal of resource management is to strive for a balance between consuming now and leaving enough for future generations. Thus, MPAs become socially acceptable if they are able to contribute to both present and future needs. The proposed SEAT indicators strive to assess whether managers are spending enough time, effort and resources to ensure that MPAs are established and maintained using sound scientific and economic principles, at the same time communities are benefitting enough so that they support their continued existence, all in the context of local economic development. SEAT is an initial attempt at measuring how the build-up of natural capital leads to the build-up of financial, human and social capital at the local level. SEAT complements the existing MPA Effectiveness Assessment Tool (MEAT), which assesses governance effectiveness in managing Philippine MPAs. A series of Focus Group Discussions (FGDs) were conducted among 17 municipalities. Efforts to roll out the SEAT are currently being exerted by the ECOFISH project in an additional 42 coastal municipalities. Results of the FGDs are discussed in this paper.

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POPULATION GENOMICS OF RESILIENCE IN THE 2015 CORAL BLEACHING EVENT (Abstract ID: 28867)

In the spring of 2015, the third major worldwide coral bleaching event in recorded history was observed across the tropics. Acroporid corals in backreef lagoons on Ofu Island in American Samoa had extremely variable responses. A few corals bleached heavily and died, while others seemed relatively unaffected by this stress. We use full genome sequencing of 150 Acropora corals to determine the genomic architecture of bleaching response during this natural bleaching event. We test whether the genomic basis of resilience to climate change is shared between congeners, and determine the spatial distribution of thermally tolerant species, subspecies, individuals and alleles across Ofu lagoon. We find that different Acropora species had broadly similar bleaching reactions, but that cryptic species within these complexes bleached differently. We show that many genetic variants are shared between species, suggesting that similar mechanisms may drive climate adaptation in different species. In particular, regulatory alleles that control gene expression for crucial loci vary much more than expected between cryptic species and may be especially responsible for bleaching resilience and microhabitat distribution. These findings suggest that adaptation to a changing climate may be accomplished through shifts in the frequencies of many regulatory polymorphisms already present in contemporary coral populations.

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DARWIN'S BERMUDA PARADOX REVISITED: ATOLL OR FRINGING REEF? (Abstract ID: 29541)

Bermuda is a carbonate platform complex in a relatively high latitude on a mid-plate seamount rimmed subaerially to S and E by islands with offshore algal-vermetid reefs to seaward, and rimmed to N and W by coral reefs. Its gross topography has long been recognized as atoll-like. Darwin did not visit Bermuda, and had to rely mostly on Nelson's geological account (1837) in his effort to classify its reefs (1842). Despite its atoll form and ocean setting, Nelson's observations inhibited Darwin from assigning Bermuda to one of his three famous reef categories. Nelson had correctly inferred an aeolian origin for its islands and noted the 10s m scale of their relief. While possibly homologous with atoll cays elsewhere, their height seemed too much for a typical atoll. Also problematic were intraformational conglomerates whose clasts were "too heavy for the wind to have moved". This was inconsistent with Darwin's atoll model of ocean floor subsidence, as posthumously illustrated by David Stoddart (1995), and pointed more to Bermuda's reefs as a fringing system around older islands. In retrospect, Darwin's Bermuda paradox is understandable in the absence of a dating framework, and because Quaternary glacioeustatic events and Bermuda's own tectonic setting were both unknowable to Darwin at that time. Bermuda is really an oceanic atoll whose particular history happens to have endowed it with an interesting, if not unique, suite of unusual features.

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DEVELOPING PRACTICAL MANAGEMENT STRATEGIES TO PROMOTE CORAL RECOVERY FOLLOWING A SEVERE BLEACHING EVENT IN HAWAII (Abstract ID: 28213)

Hawaii's coral reefs suffered extensive coral bleaching in 2014 and 2015 due to dramatically elevated ocean temperatures. In some species over 95 percent of colonies were bleached with total mortality exceeding 70 percent. Although it is predicted that mass bleaching will become an annual phenomenon in Hawaii by 2050, consensus on current strategies to promote coral recovery following bleaching mortality is decidedly limited. In 2016, the State of Hawaii Department of Land and Natural Resources, Division of Aquatic Resources launched an initiative to identify applicable and effective management actions to promote the recovery of the state's coral reefs. The initiative utilized the input of a global group of coral reef scientists and managers with relevant research and management experience who vetted and prioritized proposed management actions. Through this innovative process, a consensus on management actions was reached which is now being further analyzed by the Division of Aquatic Resources for application to potential administrative rulemaking. This project reflects a direct link from science to policy and is a unique instance where government proactively worked with scientific experts to actualize pragmatic management and policy actions. This study may serve as a model for other governments looking to develop a realistic plan to accelerate coral recovery and resilience following severe bleaching events.

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THE EFFICACY OF NURSERY HEAD-STARTING IN THE CULTURE AND RESTORATION OF ACROPORA CERVICORNIS (Abstract ID: 28842)

Four presumed-distinct genetic lineages of Acropora cervicornis at 12m depth were collected, grown and monitored bimonthly for 12 months through 2006 and 2007 in mid-water horizontal line nurseries at 3m, 7m and 15m depths in Montego Bay, Jamaica. These corals were then re-fragmented and propagules randomly re-set to new nurseries in the same locations, wherein they were similarly monitored for a further 10 months. The second, propagative iteration's corals started at faster growth rates than the previous wild-sourced for the first 100 days, after which the difference reduced to insignificance. This result suggests that head-starting does occur, supporting a nursery period of three months or more as an interim step for restorative relocation including in salvage, and supports multi-generational approaches to propagative coral enhancement under silviculture themes. Lineage differences in growth and branching rates of the first nursery iteration persisted into the second, as did the relative resistances to fouling and bleach-causing stress of those faster-growing lineages. Apical polyps of larger corals extended more rapidly than those of smaller individuals regardless of lineage or nursery conditions including depth or light, suggesting that larger corals be maintained in working nurseries to maximize overall production whenever possible. This should not negate the use of nubbins per se, but should inform programmatic design. A trend towards hardening to bleaching stressing conditions was noted in the second iteration corals.
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GROWTH AND PHYSIOLOGY OF THE CORAL TURBINARIA RENIFORMIS IN BREMER BAY, WESTERN AUSTRALIA (34.4°S): IMPLICATIONS FOR THE SUITABILITY OF HIGH-LATITUDE REFUGIA (Abstract ID: 29010)

The ongoing tropicalisation of high-latitude environments and the increasing frequency of thermal stress events on low-latitude reefs have highlighted the importance of currently marginal environments as potential future 'coral refugia'. Although temperature and light are often considered sub-optimal for coral reef accretion above 28°N and 28°S, existing high-latitude coral communities provide natural laboratories to investigate the potential for coral refugia under future climate change. We are currently measuring seasonal changes in the growth rates of Turbinaria reniformis at Bremer Bay (34.4°S) in Western Australia; a region that has warmed at rates of 0.01--0.03°C y-1 since the mid 1900's. Preliminary data show that T. reniformis increased its skeletal biomass over winter despite minimum weekly average water temperatures of just 16.5°C. Furthermore, T. reniformis grew at similar rates in winter to those reported for the same species from tropical environments grown in aquaria studies (0.06% change in mass d-1). The maximum quantum yield of chlorophyll-a fluorescence (Fv/Fm) varied seasonally with changing light levels (0.65 in June vs. 0.50 in December); results that are comparable to studies of seasonal changes in the photophysiology of tropical coral, suggesting that T. reniformis in Bremer Bay may photoacclimate seasonally to maintain net skeletal growth year-round. We anticipate that this study will provide important insights into the capacity of coral to grow in marginal environments, with implications for the future suitability of high-latitude coral refugia.

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USE OF GEOGRAPHICALLY-WEIGHTED REGRESSION TO IDENTIFY SPATIAL HETEROGENEITY IN CORAL COVER RELATIVE TO SUBMARINE GROUNDWATER DISCHARGE AND HERBIVORE ABUNDANCE (Abstract ID: 29632)

Disturbances from natural and anthropogenic threats can lead to phase shifts from coral- to algal-dominated communities. The Kahekili Herbivore Fisheries Management Area (KHFMA) on Maui, Hawaii was established in 2009 to address concerns that the reef was undergoing a phase shift based on observed declines in coral cover, ephemeral macroalgal blooms, and turf algal overgrowth of corals. The KHFMA prohibits take of all herbivorous species including reef fish and urchins to support top-down control of algal growth that may be detrimental to coral populations. Here, we synthesize multiple spatially-explicit biological and environmental data sets to evaluate the relative importance of submarine groundwater discharge and herbivore abundance to the distribution of coral cover within the management area. To address the observed spatial heterogeneity in the area, a spatially explicit Geographically Weighted Regression (GWR) was compared to a non-spatial Ordinary Least Squares (OLS) model. Both main effects and interactions between SGD and herbivore abundance were related to the distribution of coral cover. The GWR improved the fit of the model and allowed for visualization of patterns in relationships between the different variables. Local models showed that the relationship between SGD and herbivore abundance varied spatially. These results suggest that a complex interaction of both top-down (herbivory) and bottom-up (SGD) effects influences coral cover. The GWR method provided a superior method to traditional regression approaches for fine scale, spatially-explicit analyses.

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ULTRASTRUCTURAL FEATURES OF ZOOXANTHELLAE PROVIDE BIOMARKERS OF DISSOLVED INORGANIC NUTRIENT EXPOSURE OF REEF CORALS (Abstract ID: 28344 | Poster ID: 90)

Increasing enrichment of coastal waters with dissolved inorganic nutrients occurs as a result of a range of anthropogenic activities and constitutes a significant local pressure to coral reefs, having both direct and indirect impacts on reef corals. Hence, monitoring of the nutrient exposure of coral reefs is highly desirable to direct management efforts. Yet, due to the fast uptake and turnover of dissolved inorganic nutrients in coral reef waters, it is difficult to establish the prevailing nutrient conditions for reef monitoring purposes solely by analyzing the water chemistry. By conducting long-term experiments under controlled laboratory conditions and assessing the resulting zooxanthellae cellular morphology by transmission electron microscopy, we could establish ultrastructural features of zooxanthellae as reliable biomarkers of the amount of dissolved inorganic nutrients available to the corals. We demonstrate that zooxanthellae cell size, the quantity of storage bodies, and accumulation body integrity change in a characteristic way indicative of the exposure to different concentrations of nitrate and phosphate. These biomarkers allow for the identification of, and discrimination between different forms of nutrient stress, providing a potentially valuable tool for targeted management of coastal pollution.

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SIMULATED OVERFISHING PROMOTES RAPID SPREADING OF ASCIDIANS IN AN UPWELLING-INFLUENCED CORAL REEF AT THE PACIFIC COAST OF COSTA RICA (Abstract ID: 27915)

Overfishing and nutrient enrichment are major local stressors to coral reefs worldwide, as they can alter the benthic reef community by promoting fast growing and opportunistic functional groups. Reefs in the Gulf of Papagayo at the northern Pacific coast of Costa Rica are influenced by seasonal upwelling events that naturally increase phosphate, ammonia and nitrate concentrations (3, 2 and 6-fold, respectively) between December and March. This study therefore investigated the combined effects of naturally increased nutrient concentrations and simulated overfishing on the benthic community composition and succession on settlement tiles from October 2013 until April 2014. Overfishing was simulated using exclusion cages. While crustose coralline algae, sessile invertebrates (i.e. barnacles and polychaetes) and small filamentous algae dominated the tiles under natural conditions, simulated overfishing significantly increased the development of the colonial ascidian *Didemnum sp.*, with up to 80 % tile area cover. *Didemnum sp.* thereby overgrew other sessile invertebrates and crustose coralline algae within two weeks time, particularly during the upwelling season when nutrient- and organic matter concentrations in the reef were high. These findings suggest that overfishing can facilitate the growth and rapid distribution of ascidians, which may have a strong influence on the natural benthic reef community composition and especially its early succession patterns. Eutrophication may further enhance the proliferation of ascidians as it increases the food resources for filter feeders.

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DYNAMICS OF CORAL-ALGAL PHYSIOLOGY AND TEMPERATURE STRESS ASSOCIATED WITH GLOBAL CHANGE (Abstract ID: 29675)

Increasing climate variability and temperature abnormalities associated with global change are significant contributors to worldwide coral reef decline. Elevated and depressed temperatures can have profound deleterious effects on coral-algal physiology

and lead to widespread coral bleaching and mortality. In parallel experiments, we investigated the dynamics of gene expression and physiology of *Acropora yongei* to decreased (-5°C) and increased (+5°C) seawater temperature over the course of 20 days. Decreased and increased temperatures cause divergent responses on dissimilar timescales in corals and *Symbiodinium*; cold causes acute effects by day 5 but corals eventually stabilize, while heat causes bleaching by day 9 and corals continue deteriorating. Using cDNA microarrays (13,546 genes) we observed that 12.2% of hybridized genes were differentially expressed. Cold-treated corals produced more differentially expressed genes (1.8%) compared to heat-treated corals (0.6%) with little overlap between them. Temperature and time had similar effects on gene expression. Coral green fluorescent protein (GFP) concentration and green fluorescence intensity decreased with declining coral health, prior to onset of bleaching, providing evidence for use of coral fluorescence as an early noninvasive indicator of coral health. Concordantly, green fluorescence was positively correlated with*Symbiodinium* photobiology and coral growth. These experiments demonstrate that the mechanisms of response to cold and heat stressors are different and elicit distinct responses in the coral-algal symbiosis.

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## AGGRESSIVE ASCIDIAN DIDEMNUM SP. OVERGROWS BENTHIC COMMUNITIES ON PROTECTED CORAL REEFS IN THE WAKATOBI MARINE NATIONAL PARK IN SOUTHEAST SULAWESI, INDONESIA (Abstract ID: 28198)

Benthic coral reef communities are threatened by invasive and cryptogenic species,which are promoted by anthropogenic influences and pollution. In particular, ascidians have life history traits that facilitate the establishment under changing environmental conditions: they grow rapidly under eutrophic conditions, quickly reach sexual maturity, can regenerate from fragments and often lack predators. Reefs in the Wakatobi are protected but have been degraded in some areas due to overfishing, sedimentation and nutrient enrichment. Therefore, this study investigated the benthic community composition of coral reefs in the Wakatobi in a baseline survey in August 2011 (4 weeks). A special focus was put on the distribution patterns of an unidentified ascidian in the genus Didemnum. The results revealed that Didemnum sp. occurred in high abundances in non-degraded (0.66%), but to an even higher degree in eutrophic water (0.75%). Furthermore, Didemnum sp. showed the ability to overgrow dead and alive hard and soft corals with fast growth rates (up to 53% and 26% over the study period in degraded and non-degraded conditions). High eutrophic conditions along with organic matter contents are likely to promote the occurrence of filter feeders such as Didemnum sp. Moreover, the close proximity of degraded and non-degraded sites could lead to the spreading of ascidians through dispersal of larvae. The high percent cover of Didemnum sp. on protected reefs in the Wakatobi indicates a potential threat to the benthic reef community via outcompeting and should therefore be investigated further.

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## CORAL HOLOBIONT RESPONSE TO SALINITY CHANGES INDICATES OSMOREGULATION OF SCLERACTINIAN CORALS (Abstract ID: 27835)

Scleractinian corals are commonly assumed to be stenohaline osmoconformers. Yet, some corals are able to tolerate salinities up to 50 PSU, but we know little about the mechanisms involved. To this end, studies have exclusively addressed the coral host and/or their algal symbionts (Symbiodinium) upon salinity changes, but the microbiome was omitted. To further investigate the role of all compartments of the coral holobiont we assessed the response of the coral host, its symbiont algae (Symbiodinium), and the associated bacterial community to strongly increased salinities. In short-term incubations (4h) we measured decreases in calcification rate of the coral host and in the photosynthetic performance of Symbiodinium. In contrast, we found a major restructuring of the associated bacterial communities after a long-term (29 days) experiment, where no bleaching occurred and the photophysiology was unaffected. Based on the microbial changes we identified putative functional changes of the microbiome, namely an increased storage of the osmolyte polyhydroxybutyrate, a decreased reduction of the osmolyte and antioxidant DMSO, and changes in nitrogen cycling towards nitrogen fixing processes. Our results show a short-term reaction of coral host and Symbiodinium to strongly increased salinities. However, lack of an apparent physiological long-term response indicates an acclimation process that is accompanied by a microbiome community shift towards a microbiome that potentially supports increased osmolyte production.

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## EXPLORING CLIMATE CHANGE IN THE PHOENIX ISLANDS PROTECTED AREA: RECOVERY, RESILIENCE, AND RISKS (Abstract ID: 29032)

The Kiribati Phoenix Islands are located in the central Pacific, where annual temperature fluctuations are typically narrow except during intense El Niño events. When first explored in 2000, they resembled a near-pristine state, but in 2002-03, a severe high thermal event occurred. Across all islands, coral cover declined by ~60% due to bleaching, down to ~0 at some sites. Over the next decade (2003-2015), a remarkable if variable recovery was observed, with coral cover ranging from 18-95%. Recovery on the high end of this scale is attributable, at least in part, to high fish biomass and the rapid jacketing of exposed substrata by crustose coralline algae. The observed variation among sites persisted through another (but less severe) thermal event in 2010, and in 2015, while the ongoing El Nino was beginning to strengthen. Over a 15-year period, Phoenix Islands monitoring efforts have provided insight into coral successional dynamics and resilience in a coral reef region subject to intense climate impacts, but largely innocent of local human impacts. Despite the three bleaching events, adult coral community structure still resembles that of new recruits, and is dominated by fast-growing coral genera. Yet, the important differences in resilience and recovery (and hence risk) across the 8 islands likely reflect natural environmental differences in size and positioning, coupled with remnants of historical human impact. Phoenix Islands reefs are remote, largely uninhabited, and fully protected, thus making them a good case study in natural ecosystem responses to climate. http://phoenixislands.org/

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## ACCLIMATORY CAPACITY OF THE GORGONIAN *ISIS HIPPURIS*LINNAEUS 1758 TO ENVIRONMENTAL CHANGE IN SE SULAWESI, INDONESIA (Abstract ID: 28541)

Coral reefs within the Indonesian archipelago are some of the most biodiverse yet anthropogenically compromised marine ecosystems. In the Wakatobi Marine National Park, Indonesia, two distinct morphotypes of the protected zooxanthellate gorgonian octocoral Isis hippuris partition across environmental clines: long-branched bushy colonies on turbid, degraded reefs, and short-branched multi/planar colonies on healthy reefs. To test if local adaptation has lead to divergent selection through the action of environmental perturbation, a one-year reciprocal transplant experiment assessing multiple traits (45: morphological, physiological, environmental) was conducted. After one year, reduced survivorship of healthy reef morphotypes on degraded reefs implied the onset of lineage segregation through immigrant inviability. Phenotypic traits in healthy source colonies showed significant trait plasticity, whereas residents from the impacted site were insensitive to environmental change. Interestingly, photoacclimatory responses were integrated at the morphological and bio-optical levels, with host skeletal articulation maximizing the internal light field in healthy clones on degraded reefs. Variable optical responses were not, however, attributed to endosymbiont type, as all test colonies possessed a novel Symbiodinium Clade D1a. In sum, patterns of phenotypic variability within the I. hippuris holobiont likely represent incipient ecological divergence, with a high capacity for plasticity that has become fixed through on-going anthropogenic disturbance on degraded reefs.

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QUANTIFYING HERBIVORY ON CORAL REEFS TO DEVELOP A METRIC FOR MANAGEMENT AND CONSERVATION OF CARIBBEAN PARROTFISHES (Abstract ID: 28510 | Poster ID: 581)

On many coral reefs, parrotfishes serve as both important fishery species that support local economies and key grazers that can facilitate settlement, growth, and survivorship of reef-building corals. Recent management priorities have recognized the importance of parrotfish in facilitating coral recovery, particularly in the US Virgin Islands. However, we lack species-level information needed to guide specific management targets. To fill this knowledge gap, we first quantified and compared the feeding behavior of the six most abundant large bodied parrotfish species in the genera Scarus and Sparisoma by conducting detailed behavioral observations of grazing rates and grazing preferences at three sites in St. Croix, US Virgin Islands. To relate these behavioral data to ecosystem status, we also quantified fish abundance and benthic community structure at our study sites. Our results show large differences in diet, preferred grazing substrates, bite rate, and distance travelled while foraging among species and between genera of parrotfishes. We will use this species- and size-specific foraging behavior data to quantify the ecological function provided by the parrotfish assemblage. The final phase of this project will be to use our grazing metrics to model the grazing potential of the parrotfish assemblage and forecast the impacts of different management strategies on the ability of the parrotfish assemblage to control algae and facilitate the protection of corals.

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CLOSE ENCOUNTERS OF THE SIBLING KIND: SELF-RECRUITMENT AND KIN ASSOCIATIONS IN SOCIAL GROUPS OF A CORAL REEF CARDINALFISH (Abstract ID: 28543)

Social groups of coral reef fishes are often assumed to form from unrelated individuals that settle into the same coral habitats. However, local-scale self-recruitment and attraction between sibling larvae create the potential for kin associations within social groups and inbreeding. While there is increasing evidence that larval reef fishes may return home and kin remain associated during the larval phase, few cases of true kin group structures in marine fish have been described. Here we examined relatedness between individuals within and among reefs and within and among social groups of the pyjama cardinalfish, Sphaeramia nematoptera, in Kimbe Bay, Papua New Guinea. We quantified the pairwise relatedness and genetic distance among more than 13000 dyads from 41 social groups on 7 reefs, using 19 microsatellite markers. We found a strong negative relationship between pairwise relatedness and distance within an area less than 3km. Dyads were 1.3 times more closely related within reefs than between reefs and relatedness was higher between individuals within social groups compared with among groups on the same reef. We observed high levels of both fine-scale self-recruitment and siblings settling together, suggesting these mechanisms account for high levels of kin association within groups. However, there is some evidence of ontogenetic shifts of kin within groups suggestive of a mechanism to avoid inbreeding. Assumptions that social groups in coral reef fishes are made up of unrelated individuals may need to be re-evaluated.

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A DYNAMIC MODEL OF THE INTERACTIONS BETWEEN ACROPORA CERVICORNIS AND ITS ENVIRONMENT (Abstract ID: 29404 | Poster ID: 526)

Environmental factors associated with climate change such as increasing sea surface temperature (SST) and solar radiation (SR) have negatively impacted corals throughout their geographic ranges. One such coral, which has been seriously impacted by these stressors, is the staghorn coral Acropora cervicornis. To reduce the effects such stressors, this coral utilize fluorescent proteins (FPs) and melanin. These constitutive immune components quench reactive oxygen species (ROS) produced during thermal stress and absorb or reflect potentially damaging light. The synthesis of these components are, nonetheless, energetically costly. Hence, production of these protective compounds may be traded-off against other vital functions such as growth. In this study we develop a mathematical model with a system of ordinary differential equations that simulates the growth of A. cervicornis branches under different regimes and combinations of SST and SR. The model assumes that polyps are the functional unit of the coral and that the concentration of FPs and melanin are directly proportional to SST and SR intensity, which in turn, are inversely proportional to growth. To develop the model we use empirical (birth and mortality rate of polyps and the maximum number of polyps per unit area) and theoretical parameters (concentration of FPs, melanin produced, and trade-offs with growth). The model simulates how changes in FPs and melanin due to environmental changes affect the growth capacity of A. cervicornis. The model will thus help in understanding how corals will respond to future changes in climate.

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TRANSCRIPTOME CHANGES IN CORALS SUBJECT TO PROTECTIVE HEAT PULSES DURING MIDDAY LOW TIDES (Abstract ID: 28207)

Reef-building corals face many types of environmental stress. Extreme stress exposure can result in loss of endosymbionts, leaving colonies bleached. However, corals are commonly exposed to natural cycles of sub-bleaching stress, which may increase their thermal tolerance in the lead up a bleaching-inducing stress event. We monitored coral transcription daily for 17 days over a strong tidal cycle and show that sub-bleaching environmental stress triggers a strong protective transcriptional response. These data allowed us to identify a set of genes with coordinated expression that were activated only on days with strong tides, high temperature, and strong diel pH and oxygen changes. The responsive genes are enriched for gene products essential to the Unfolded Protein Response, a cellular response to endoplasmic reticulum stress. After the temporary mild environmental stress passed, expression of these genes immediately decreased suggesting that homeostasis was restored to the endoplasmic reticulum. In a laboratory temperature stress experiment we found that the expression of these environmentally responsive genes was highest in bleached corals suggesting that they may also play a role in the physiological adjustments that occur during bleaching. Our results suggest that the Unfolded Protein Response is a first line of defense that corals initiate when coping with environmental stress and enhances our understanding of coral stress physiology during a time of major concern for reefs.

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CHANGING PHYTOPLANKTON ASSEMBLAGES IN RESPONSE TO INCREASING CO2 CONCENTRATION: MESOCOSM EXPERIMENT IN BARRANG LOMPO ISLAND, SOUTH SULAWESI, INDONESIA (Abstract ID: 27979 | Poster ID: 371)

We examine the effects of seawater pCO2 concentration of 280, 380, 550, 650, 750 and 1000 ppm on the changing of phytoplankton assemblage through mesocosm experiment in Barrang Lompo Island. The experiment was run for 48 and 96 hours of incubation periods without nutrient enrichment. The aim of the study was to examine the effect of increasing CO2 concentration on changing phytoplankton assemblages. The result showed that carbonate parameters (alkalinity, DIC, PIC and POC) were affected significantly with increasing CO2 for both incubation periods. Bacillariophyceae was the most important algal group accounting for 74.5% for 48 hours of incubation period. Morever, Diatomaceae was the most dominant algal group (50.9%) for 96 hours of incubation period. There was no clear trend of Shannon diversity (H') and Evenness values between CO2 concentration and incubation period. There was clear grouping of species assemblages between incubation periods based on nMDS analysis. ANOSIM result showed that there was no significant different of species assemblages among CO2 treatments. On the other hand, there was a significant different of species assemblages among incubation periods between CO2 concentration treatments. The highest dissimilarity was found at the pair of 650 ppm vs 1000 ppm, account for 83.15%. Three taxa that were the most responsible for dissimilarity were Rhizosolenia fragilissima (10.1%), Gyrosigma acuminatum (9.3%), Biddulpia sinensis (9.2%). Keywords : Phytoplankton assemblages, increasing CO2 concentration, mesocosm experiment, Barrang Lompo Island

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BLACKTIP REEF SHARKS (CARCHARHINUS MELANOPTERUS) SHOW HIGH CAPACITY FOR WOUND HEALING AND RECOVERY FOLLOWING INJURY (Abstract ID: 28034 | Poster ID: 277)

Wound healing is important for sharks from the earliest life stages -- for example, as the 'umbilical scar' in viviparous species heals -- through adulthood where sharks can incur a range of injuries from natural and anthropogenic sources. Despite anecdotal accounts of rapid healing in elasmobranchs, data regarding recovery and survival from different wound or injury types has not been systematically collected. In blacktip reef sharks, we documented:

1) 'umbilical scar' healing in wild-caught neonates reared for 30d in flow-through laboratory aquaria in French Polynesia; 2) survival and recovery of free-swimming individuals in Australia and French Polynesia following a range of injuries; and 3) long-term survival following suspected shark-finning activities. Laboratory monitoring, tag-recapture records, telemetry data, and photo-identification records suggest that blacktip reef sharks have a high capacity to survive and recover from small to even large and severe wounds. Healing rates, recovery, and survival are important factors to consider when assessing impacts of habitat degradation and fishing stress on shark populations. However, individual survival may depend more on handling practices and physiological stress rather than the extent of physical injury. Our findings also contribute to discussions regarding the ethics of tagging practices used in elasmobranch research and provide baseline healing rates that may increase the accuracy in estimating reproductive timing inferred from mating scars and birth dates for neonates based on umbilical scar healing status.
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EPIZOOTIOLOGY OF BLACK BAND DISEASE ON SCLERACTINIAN CORALS OF KAUAI, HAWAII, USA (Abstract ID: 28914 | Poster ID: 159)

Since its discovery in the Florida Keys in 1973, black band disease (BBD), a tissue loss disease that infects multiple coral genera in the Caribbean, Red Sea, and Indo-Pacific, has emerged as a serious threat to the reefs worldwide. BBD is a polymicrobial disease consisting of three main microorganisms: a filamentous cyanobacterium, sulfide-oxidizing bacteria, and sulfate-reducing bacteria. In 2011, the first potential outbreak of BBD was reported in the Hawaiian Archipelago off the Island of Kauai. Histology and microscopy of coral lesion samples from Kauai revealed a mixed assemblage of motile cyanobacteria and filamentous bacteria associated with cell necrosis. Laboratory infection trials demonstrated that BBD lesion material infected 94.4% of exposed coral within 4 days of inoculation (n=18). Amplification and sequencing of 16S rRNA and dsrA genes from bacteria cultured from disease lesions identified a cyanobacterium similar to *Pseudoscillatoria coralii*, a sulfide-oxidizing *Beggiatoa* sp., and several sulfate-reducing bacteria; showing that the three common BBD constituents are present in lesion material from Kauai. Surveys found BBD widespread on the north and east facing shores of Kauai with disease prevalence ranging from 0.24% to 7.9%; it was observed to infect three reef-building *Montipora* species. In other regions, BBD prevalence increases with elevated water temperatures, and this trend was observed with BBD on the reefs of Kauai. This first report of BBD in Hawaii which extends the geographic range of this disease.

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SPECTRAL REFLECTANCE OF PALAUAN REEF-BUILDING CORAL WITH DIFFERENT SYMBIONTS IN RESPONSE TO ELEVATED TEMPERATURE (Abstract ID: 27958)

Spectral reflectance patterns of corals are driven largely by the pigments of photosynthetic symbionts within the host cnidarian. The warm inshore bays and cooler offshore reefs of Palau share a variety of coral species hosting different dinoflagellates (genus: Symbiodinium), with thermally resistant S. trenchii (=type D1a or D1-4) predominating under elevated temperature regimes inshore, and primarily Clade C types in the cooler reefs offshore. Spectral reflectance of two species of coral, Cyphastrea serailia and Pachyseris rugosa, from both Inshore and Offshore locations shared multiple features between sites and to global data from other studies. No clear reflectance features were evident which might serve as markers of thermally tolerant S. trenchii symbionts compared to the same coral species with different symbionts. Reflectance from Inshore C. serailia colonies had a fluorescence peak at approximately 500 nm which was absent from Offshore samples. Integrated reflectance across visible wavlengths had an inverse correlation to symbiont cell density and could be used as a relative indicator of the symbiont abundance for each type of coral. As hypothesized, coral colonies from Offshore with Clade C symbionts showed a greater response to experimental heating, manifested as decreased symbiont density and increased reflectance or "bleaching' than Inshore counterparts with S. trenchii. Although no unique spectral features were found to distinguish symbiont types, spectral differences related to symbiont abundance could prove useful in field and remote sensing studies.
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PARROTFISH HERBIVORY AND POTENTIAL RECOVERY OF CORALS IN THE CARIBBEAN: USING SPECIES-LEVEL DATA TO PREDICT ASSEMBLAGE-LEVEL IMPACTS (Abstract ID: 29606)

Coral reefs have been in decline for many years throughout much of the Caribbean. While the causes are still debated, the loss of herbivores and subsequent increase in algae has likely played an important role in many locations. In recent years, there have been increasing calls for protection of key herbivores, especially parrotfishes, since increasing parrotfish abundance should reduce algal cover and algal competition with corals and/or provide additional free space for coral settlement. While protection of herbivores in general should increase herbivory, different species have different feeding and habitat preferences, and therefore should have different impacts on benthic communities. Therefore, the grazing impact of parrotfish assemblages may vary dramatically with changes in assemblage structure. We use data on species-level grazing preferences of parrotfishes in the Florida Keys and USVI combined with long-term monitoring data on parrotfish abundance to predict overall assemblage-level grazing impacts. Our results show that overall grazing impacts vary dramatically both geographically and among habitat types, suggesting that different parrotfish assemblages are likely to have very different impacts on benthic algae, and therefore also vary in the strength of indirect effects on corals. Our approach can provide concrete predictions for reef managers about how changes in parrotfish assemblages may influence grazing, algae, and corals using widely-available reef fish monitoring data, thereby providing a powerful tool to improve management coral reef ecosystems.

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TWENTY YEARS OF CHANGE AND IMPACTS OF THE 2014/2015 BLEACHING EVENT ON FLORIDA KEYS REEFS (Abstract ID: 29810)

Corals in the Florida Keys have been subjected to elevated thermal stress for two consecutive years (2014 and 2015) due to a strengthening El Nino weather pattern. Moderate to severe bleaching has been documented in 2014 and 2015 with extensive bleaching persisting well into the cooler, winter months. The last mass, widespread bleaching event in the Florida Keys coincided with the 1997/1998 El Nino and reduced coral cover by up to 40% on some reefs. The Coral Reef Evaluation and Monitoring Project (CREMP) documented this mass mortality and has studied the condition of reefs in the Florida Keys since 1996. CREMP performs annual assessments at 40 sites and the data collected has provided invaluable information on how the benthic assemblages have changed on Florida Keys reefs the last 20 years. At the time of the 1997/1998 El Nino, only benthic cover estimates (e.g. change in percent cover) were available to describe the effects of bleaching. In contrast, the metrics used to evaluate the current 2014/2015 event include a robust demographic dataset that assesses the changes in density and population structure of corals (e.g. size classes and living tissue estimates), in addition to the more conventional percent cover estimates. Using a combination of traditional techniques (percent cover) coupled with more progressive population measures will allow for the most comprehensive assessment of a mass bleaching event in the Florida Keys to date. This presentation will summarize changes in coral abundance after the 2014/2015 bleaching years and place the results within the context of how Florida Keys reefs have changed the last 20 years
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REEF FLAT CORES FROM THE INSHORE GREAT BARRIER REEF PRESERVE RECORDS OF HOLOCENE REEF GROWTH, TERRESTRIAL SEDIMENTATION AND TROPICAL CYCLONES (Abstract ID: 28416)

Multiple natural and anthropogenic stressors threaten inshore coral reefs of Australia's Great Barrier Reef (GBR) located in relatively turbid and shallow water. To better understand present and future reef response to various stressors, baseline long-term data on coral reef growth is required. Growth chronologies of coral reefs can provide valuable insight into past reef development and variability and can further our understanding of present reef condition. We examined the chronostratigraphy of five fringing reefs on the inner and mid-shelf regions of the central GBR that are located on a gradient of

distance from the coast and associated anthropogenic impacts. Our record is based on 41 reef cores that capture the entire Holocene reef framework and matrix sequence, terminating in pre-reefal substrates. Cores are chronologically constrained by 112 high precision U-Th ages from in situ corals in the cores and fossil microatolls. Reef initiation age, antecedent substrate, reef accretion rates and mode, and coral palaeo-ecology varied between the five sites. However, reef flat formation began in the mid-Holocene at all sites with approximately 80% of each reef structure emplaced by 2,000 yBP and little net accretion occurring since. Late Holocene sea-level fall, tropical cyclones and sedimentation influenced Holocene reef accretion at each site to varying degrees. Terrestrial sedimentation was markedly greater on inshore sites, while the physical effects of tropical cyclones on reef development and geomorphology were more pronounced at sites further from the mainland.

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VIRAL OUTBREAK IN CORALS ASSOCIATED WITH AN *IN SITU* BLEACHING EVENT: ATYPICAL HERPES-LIKE VIRUSES AND A NEW MEGAVIRUS INFECTING *SYMBIODINIUM* (Abstract ID: 29652)

We conducted transmission electron microscopy imaging and virome analysis in tandem to characterize the most conspicuous viral types found within the dominant Pacific reef-building coral genus *Acropora*. Collections for this study inadvertently captured what we interpret as a natural outbreak of viral infection driven by aerial exposure of the reef flat coincident with heavy rainfall and concomitant mass bleaching. Three of the dominant VLPs identified were observed in all tissue layers and budding out from the epidermis, including viruses that were ~70 nm, ~120 nm, and ~150 nm in diameter; these VLPs all contained electron dense cores. These morphological traits are reminiscent of retroviruses, herpesviruses, and nucleocytoplasmic large DNA viruses (NCLDVs), respectively. Some 300-500 nm megavirus-like VLPs also were observed within and associated with *Symbiodinium* cells. Abundant sequence similarities to a gammaretrovirus, herpesviruses, and members of the NCLDVs, based on a virome generated from five *Acropora aspera* colonies, corroborated these morphology-based identifications. Additionally, sequence similarities to two diagnostic genes, a MutS and a DNA polymerase B gene (based on reannotation of sequences from another study), most closely resembled *Pyramimonas orientalis* virus, demonstrating the association of a cosmopolitan megavirus with *Symbiodinium*. This study suggests that viral outbreaks may be a common but previously undocumented component of natural bleaching events.

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GENETIC SEASCAPE REVEALS THAT ECOLOGICAL-EVOLUTIONARY PATTERNS IN PORITES PANAMENSIS CONFORM TO RELAXED VERSION OF THE ABUNDANT CENTRAL HYPOTHESIS (Abstract ID: 28734)

The coral fauna of the Eastern Tropical Pacific (ETP) is depauperate and peripheral; therefore, it is important to understand the factors allowing its survival. Here, we use a genetic seascape approach to test genetic predictions of the relaxed version of Abundant Center Hypothesis (rel-ACH) in *Porites panamensis*, a hermatypic coral endemic to the ETP. The relative abundance patterns of *P. panamensis* in the Mexican Pacific revealed that the northern populations from the Baja California peninsula are the center of abundance while the southern continental populations along the continental margin are peripheral relative to it. Genetic patterns of diversity and structure of nuclear DNA sequences (ribosomal DNA and single copy open reading frame) and five alloenzymatic loci are in agreement with ecological niche modeling. We found higher diversity levels in the peninsular populations and a significant differentiation between peninsular and continental colonies. In addition, continental populations showed higher levels of differentiation and lower connectivity among each other than peninsular populations. The geographic patterns of abundance, genetic diversity, genetic structure, and gene flow among populations are mostly consistent with the rel-ACH.

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INFLUENCE OF A TEMPORAL MACROALGAL BLOOM ON REEF FISH COMMUNITY STRUCTURE IN NORTHWEST CALUMPANG PENINSULA (Abstract ID: 28641 | Poster ID: 261)

An unusually dense benthic algal bloom occurs in Northwest, Calumpang Peninsula during the first few months of every year (February-April). We examined the impact of this event on reef fish community structure in three periods: Before the bloom (November 2015 & January 2016), During the bloom (April-May 2015), and After the bloom (July-August 2015). Benthic community surveys and fish visual census for both reef fish adults and recruits were conducted in two stations in the study site. For each station, two permanent 50x10m belt transects were laid and surveyed for both recruits and adults. Within the permanent belt transects, an additional four 50x2m belt transects were laid randomly for recruit surveys. Initial results showed three important findings: (1) adult fish community structure was highly similar during the three periods (2) highest fish species richness was recorded during the bloom, and (3) species composition of recruits was consistently different across periods. Analysis of similarities (ANOSIM) show that the presence/absence of recruits of Acanthochromis polyacanthus, Cirrhilabrus cyanopleura, Thalassoma lunare, and Pseudanthias huchtii strongly contributed to the dissimilarity in community assemblage between periods. However, the temporary increase in benthic algal cover did not cause significant negative change in the adult reef fish assemblage of the study area.
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EXPORTING FIJI'S NATURAL CAPITAL: CHALLENGES FOR THE SUSTAINABLE MANAGEMENT AND INTERNATIONAL TRADE OF INSHORE RESOURCES IN THE PACIFIC (Abstract ID: 28223)

Exports of inshore fisheries products from Pacific Island nations have grown in recent decades as global demand increases. These changes and their implications for coastal communities and resources are poorly documented or understood, despite the fact that many reef-associated fishes and invertebrates are declining. Using Fiji as a representative Pacific Island Country, we investigated the export trade of Fiji's inshore fisheries resources and the challenges associated with managing this trade. We found overall that large volumes of inshore fisheries resources are exported, potentially compromising local food security and livelihoods, though various biases and shortcomings exist in available data, including: inconsistent and underreporting; misclassification in government records; lack of regular inspection of export shipments; mismatches between volumes recorded as exported by Fiji and importing countries; and inaccuracies in reporting country of origin in the case of transhipments. To improve enabling conditions to better support inshore fisheries management in Fiji and the Pacific region, we recommend: taxation of exports and/or quotas to protect local food security and increase benefits to source countries; development of a blacklist of traders with poor trade reporting and exploitation records; development of inshore fisheries management divisions to balance current resourcing for offshore fisheries management; protecting vulnerable species from domestic and export trade, and improved monitoring systems that directly feed into decision-making for management.

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SEASCAPE GENETICS ALONG ENVIRONMENTAL GRADIENTS IN THE ARABIAN PENINSULA: INSIGHTS FROM DDRAD SEQUENCING OF ANEMONEFISHES (Abstract ID: 28009)

Understanding the processes that shape patterns of genetic structure across space is a central aim of landscape genetics. Here, we evaluated the genomic composition of the two-band anemonefish Amphiprion bicinctus across its entire geographic range in the Red Sea and Gulf of Aden, as well as its close relative, Amphiprion omanensis endemic to the southern coast of Oman. Both the Red Sea and the Arabian Sea are complex and environmentally heterogeneous marine systems that provide an ideal scenario to address these questions. Our findings confirm the presence of two genetic clusters previously

reported for A. bicinctus in the Red Sea. Genetic structure analyses suggest a complex seascape configuration, with evidence of both Isolation by Distance (IBD) and Isolation by Environment (IBE). In addition to IBD and IBE, genetic structure among sites was best explained when two barriers to gene flow were also accounted for. One of these coincides with a strong oligotrophic-eutrophic gradient at around 16-20˚N in the Red Sea. The other agrees with an historical bathymetric barrier at the straight of Bab al Mandab. Finally, these data support the presence of inter-specific hybrids at an intermediate suture zone at Socotra and indicate complex patterns of genomic admixture in the Gulf of Aden with evidence of introgression between species. Our findings highlight the power of recent genomic approaches to resolve subtle patterns of gene flow in marine seascapes.

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CORALLINE GEOCHEMICAL SIGNATURE TO IDENTIFY ANTHROPOGENIC INFLUENCES ON INSHORE CORAL REEFS OF MAGNETIC ISLAND, GREAT BARRIER REEF (GBR) (Abstract ID: 29072 | Poster ID: 432)

Although the GBR is the best managed coral reef system in the world, its initial inshore coral cover has decreased significantly in last few decades. This has been thought to be related to poor water quality associated with massive land use changes and rapid expansion of the ports along east coast of Queensland. However, due to lack of scientific evidences it has not been possible to adequately and objectively evaluate if the degradation of corals is a natural phenomenon or caused by human induced deterioration of water quality. In order to remedy this deficiency, we have unlocked the past 30 year geochemical signals from a Porites coral cored from Magnetic Island, GBR. The Magnetic Island's fringing reefs are influenced by terrestrial influx from the Burdekin catchment and also by resuspended fine sediment plume during dredging operations undertaken at the Port of Townsville. A close association among Ross River discharge, Mn/Ca, and Y/Ca has been observed. A sharp increase in total rare earth element concentration from 2006 to present coincides with the increased flood frequency during this time window. A major goal of this current work is to disentangle the impact of natural and human induced environmental change, principally by correlating the timing of abrupt changes in high-resolution coralline geochemical signatures with the specific natural and anthropogenic drivers. This work will allow better decision making where the best balance environmental protection and economic benefit can be achieved by developing best practise strategies for coastal land use.

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TAXONOMIC STUDY OF CORAL ASSOCIATED FISHESAND THEIR PARASITES OF SAINT MARTIN'S ISLAND IN THE BAY OF BENGAL (Abstract ID: 29411 | Poster ID: 254)

This paper provides a detail first time taxonomical study of coral associated fish and their parasites from St. Martin's Island of Bay of Bengal. The information be gathered which will enable the compilation of a checklist and identification guide. St. Martin's Island is the only coral island of Bangladesh. Tourism has been increased deliberately which is posing threat to the island and its biodiversity although Bangladesh Government has declared this island as Ecologically Critical Area (ECA) in 1999. Fish surveys were conducted from February, 2014 to December, 2015 in the seven visits. Fish specimens were collected from local fishermen in the fish landing zone and fish market and also from local boys who collect these fishes by using hook and line. After that specimens were preserved in cool box till transfer at -20—Among coral associated fish 40 species of 28 genera and 19 families under 3 orders (Perciformes, Beryciformes and Scorpaeniformes) were identified on the basis of morphometrics and meristics. Among three orders, Perciformes was dominant and which belongs 17 families and 37 species, whereas other two orders contain only single family of each. For parasitic observation,33 fish individuals of the10 species were studied and among them12 individuals of the 4 species were infected by parasites only. Single nematode and 122 larval cestodes were identified and their prevalence and intensity were 36.36% and 10.25 respectively. Prevalence of larval cestodes(33.33%)was greater than nematode (3.03%) and male fish(27.27%) was more infected than female (9.09%).

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THE CIVIL RESOURCE VIOLATIONS SYSTEM (CRVS) UTILIZING HAWAII'S ADMINISTRATIVE CODE TO IMPROVE ENFORCEMENT AND ADJUDICATION OF MARINE RESOURCE VIOLATIONS (Abstract ID: 29045)

In Hawaii, virtually all enforcement of marine resource violations is handled through the issuance of criminal citations. This process, which requires the defendant to appear in court for a hearing, is costly and time-consuming for judges, prosecutors, defense attorneys, enforcement officers, and defendants. Additionally, overcrowded court dockets often preclude the careful deliberation necessary to understand complex natural resource issues and laws, resulting in inconsistent rulings and dismissed cases. As an alternative to criminal prosecution, Hawaii law authorizes the use of a civil administrative code, the Civil Resource Violations System (CRVS), to process marine resource violations. Under CRVS, enforcement officers can issue civil citations akin to parking tickets which are processed administratively by the Department of Land and Natural Resources (DLNR), rather than through the criminal court system. This presentation will explore the many benefits and challenges of utilizing CRVS to enforce and adjudicate marine resource violations. It also outlines additional policy changes that would further strengthen CRVS as an enforcement tool.

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POPULATION GENOMICS REVEALS CRYPTIC HYBRIDIZATION IN A CORAL REEF FISH (GENUS: *DASCYLLUS* ) (Abstract ID: 28215)

Cocos (Keeling) and Christmas Islands sit at the border of the Indian and Pacific Ocean bioregions. They represent a secondary contact zone for multiple marine species and populations that were isolated during Pleistocene glaciations. They are considered a marine suture zone, where closely related species from separate biogeographic regions overlap and interbreed. To date, 15 cases of hybridization between coral reef fishes have been documented in this region, making it an interesting area for speciation studies. In this project, Restriction Site Associated DNA sequencing (RADSeq) indicates hybridization between highly differentiated Pacific and Indian Ocean genetic clades of the three-spot dascyllus, *Dascyllus trimaculatus*. Since there are only subtle differences in color between Indian and Pacific populations, hybridization in this pair had remained undetected. These analyses reveal that the pattern within the suture zone is not homogeneous: Cocos Islands have a genetically stable population that underwent hybridization in the past, whereas hybridization is ongoing at Christmas Island. Further, we examine if introgression occurs more often on genomic regions under selection, promoting (or slowing) adaptive divergence. This project exemplifies how genomic techniques are unraveling more cases of hybridization in marine suture zones, while showing that patterns of introgression can be quite different at relatively small spatial scales. This research is important for understanding how hybridization contributes to evolutionary novelty of Indo-Pacific coral reefs.

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IRREGULAR PLEISTOCENE PLATFORM BENEATH HERON REEF SOUTHERN GREAT BARRIER REEF (Abstract ID: 28988)

The geological record of fossil reefs provides essential information for interpreting palaeo-climatic change during the Holocene. Environmental influences on reef-building corals, such as variations in sea-level and sea-surface temperature, may cause significant differences in reef development and evolution. However, the early development of Holocene reefs is still poorly known. New drilling in the southern Great Barrier Reef is providing insights on classic reef models and relationships between Holocene reefs and Pleistocene antecedent topography. Five new cores collected in 2014 on the windward margin of Heron Reef suggest a much more irregular underlying topography than expected. Cores were recovered to depths of 30 m with new U-series ages constraining growth between 8472±24 and 2287±16 years. One core penetrated Pleistocene basement at ~ 15.3 m with Holocene reef growth initiated by ~ 8.4 ka. However, 1.77 km west along the same margin, four cores failed to penetrate Pleistocene basement at

depths of 19.6, 19.7, 24 and 30 m respectively, suggesting that the margin at that location overlies a karst valley or alternatively, there is no local antecedent platform there. A 48 m-long margin-perpendicular transect involving three cores shows that the topographic low is filled by a prograding succession, in places at least 30 m thick, beneath the current reef margin. These findings provide new insights into relationships between antecedent topography and subsequent reef growth and Holocene carbonate production and retention rates.

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PATCH-REEFS IN THE CIENAGA DE ORO FORMATION (OLIGOCENE–MIOCENE, SAN JACINTO FOLD BELT, NW COLOMBIA) (Abstract ID: 28305 | Poster ID: 391)

Coral patch-reefs occur in thin carbonate bodies (up to 20 m thick) at the top of the Ciénaga de Oro Formation, which comprises thick successions of sandstones, siltstones, and clays within the Cenozoic deposits of the San Jacinto Fold Belt in the southern Caribbean (Colombia). In the Canta Gallo quarry, 40 km east of Montería, carbonate lithofacies reflect a rapid transgression of middle-ramp branching coralline algal floatstone to rudstone over shallow-water bioclastic sandstone. Rhodolith floatstone and packstone with dispersed platy corals initiate a regressive pattern continued by coral mixstone (3 m thick) and platestone (1.5 m thick), which make up the patch-reef deposits. The top of the carbonate sequence consists of trough cross-bedded rudstone with terrigenous grains rich in sand dollars, representing shoal sediments. Strong cementation and recrystallization of coral-rich lithofacies prevent any precise identification of coral taxa. Poritids, agathiphylliids, pocilloporids (Stylophora), and mussids seem to be the main components. Sr-isotope chemostratigraphic data indicate the Ciénaga de Oro Formation is Late Oligocene to Early Miocene in age. Larger benthic foraminifers suggest an Oligocene age for the Canta Gallo carbonates. These patch-reefs extend the geographic distribution of zooxanthellate coral records of this age farther south in the Caribbean.

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FLUORESCENT PATTERNS IN CORALS FUNCTION IN SOLAR ENERGY MODULATION. (Abstract ID: 30135)

The striking fluorescent colors of corals are due to green fluorescent protein (GFP) type pigments. There is an increasing experimental evidence that one of their major roles is in photobiology. However, the function of intricate patterns made by multi-colored GFPs overlying anatomical macro- and microstructures are poorly understood. Using a combination of optical microsensor, confocal microspectral and micro-PAM fluorescence techniques we investigated GFPs' cellular localization, optical properties and photoresponses of symbionts in fluorescently patterned corals and examined their distribution in relation to the underlying skeleton. GFP tissue concentration correlated with strong surface light scattering and was highest in high light corals, especially those with dense cyan and green GFP-granules in oral disc fluorochromatophores. GFP patterns correlated with sub-surface light intensity and spectral gradients and acted in concert with skeletal elements to strongly enhance light propagation into shaded deeper tissues in fleshy or in shade adapted corals. Certain GFP cell micro-structures increased light propagation by several hundred micrometers forming effective light guides that amplified symbiont photosynthesis. Light-induced polyp contraction and expansion altered light propagation properties of GFP patterned tissues forming a dynamic light modulatory system. Together these results support a conclusion that GFP patterns redistribute and channel light towards or away from photosynthetic absorption forming an efficient biophotonic system that dynamically regulates solar energy.

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EXCEPTIONAL MULTI-GENERATION PEDIGREE AND KIN RELATIONSHIPS IN A NATURAL CORAL REEF FISH POPULATION (Abstract ID: 28581)

Multi-generation pedigrees can provide a unique baseline to investigate some of the major issues in evolutionary biology, including local adaptation, inbreeding depression and evolutionary responses to rapid environmental changes. Accurate pedigrees are challenging to obtain in nature and a multi-generational pedigree has never been constructed for a marine fish population. The complex life-cycle of marine fishes makes it difficult to track individuals through space and time, and to measure their contribution to the next generation. Here we present a unique study that built an accurate pedigree over five generations in a natural reef fish population, using data from a 10-year genetic survey of orange clownfish (*Amphiprion percula*) surrounding Kimbe Island (Papua New Guinea). The pedigree contains 502 founders at its base and includes 990 parent-progeny links, spread over 121 families. The pedigree reveals successful inbreeding between related individuals. The average dispersal distance from founders to their descents increases with each generation, suggesting families spread out over time. Multi-generational pedigree and quantitative genetic approaches allowed us to investigate the relative contribution of genetic and environmental factors to variation in individual local reproductive success. Investing in the development of multi-generational pedigrees will improve our understanding of fish population dynamics and short-term evolutionary responses to environmental change.

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ADDRESSING UNCERTAINTY: ENABLING APPLICATION OF SCIENCE TO CORAL REEF CONSERVATION POLICY AND PRACTICE (Abstract ID: 28234)

Scientists working alongside planners and managers to achieve effective coral reef management are exposed directly to the challenge of reforming often entrenched policy and practice. This challenge is compounded by the rates of climate and other socioeconomic changes pervading the world and calls for expedited ability to respond to emerging needs. Cutting edge science and models addressing coral reef resilience in the face of change and uncertainty are advancing faster than the ability to transform conservation planning and management approaches. Examples of sociopolitical obstacles to such transformation include: uncertainty of climate change projections, impacts and responses; entrenched governance structures that make change through the political process daunting; other perceived priorities (e.g., enforcement). Growing concern for climate impacts and the need to respond provide an opportunity to change governance structures. Making these more adaptive and designing and managing MPA networks for resilience to change provide a potential solution to uncertainties facing conservation agencies.

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THE SURPRISING ROLE OF TELEOSTS IN REEF SYSTEM INORGANIC CARBON CYCLING (Abstract ID: 28174 | Poster ID: 88)

Concerns regarding the future of coral reefs in the face of rising sea surface temperatures (SSTs) and ocean acidification (OA) are growing apace. Reef system responses to these pressures will, in part, depend on the carbonate chemistry of waters surrounding them. However, changes in reef system carbonate chemistry are difficult to predict because a complex series of biogeochemical alterations and feedbacks may be triggered by rising SSTs and/or OA, possibly acting to buffer against them. In addition, several key components of reefal carbon cycling are poorly understood. Resolving these issues is vital for predicting future reef health and developing effective management strategies. Here we highlight teleost fish as a poorly understood but potentially key component of inorganic carbon cycling around reefs. Marine teleosts continuously excrete CaCO3 as a waste product of osmoregulation, and global models suggest this process could account for up to 45 % of total marine CaCO3 production. Thus, fish CaCO3 may be a highly significant component of global inorganic carbon cycles. Since reefs are historically sites of high fish biomass, fish CaCO3 could be similarly important within these systems, and may become increasingly so with rising SSTs and OA, as both are predicted to promote increased production rates. However, the significance of fish CaCO3 as a control on reef system chemistry is ultimately determined by fish biomass, which is presently undergoing drastic decline in many reef systems. We examine these issues through studies from Bahamian and Australian reef systems.

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LIFE ON THE EDGE: CORAL REEF FISHES EXHIBIT STRONG BIDIRECTIONAL RESPONSES TO EDGE HABITAT (Abstract ID: 29924)

Habitat edges commonly support discrete communities compared to adjoining habitat types. Coral reefs are often adjacent to other habitats, e.g. sand, but little is known about how reef-associated organisms respond to the presence of edges. Here, we explored how fish and benthic assemblages changed with distance from a coral reef-sand edge. At each site (n=25), 30 m transects were placed at five positions: one along the edge and at 5m and 10 m away from the edge into reef and sand habitats. Counts were made of 51 fish species. Benthic composition was surveyed and hard corals identified to genus level. Multivariate analyses revealed that the fish community along the edge was significantly different to the fish communities only 5 to 10 m into both the sand and reef habitats. Over half of the 51 fish species showed a clear directional response to the presence of an edge. 12 species were significantly more abundant along the edge, including the wrasse *Thalassoma lunare* which was 30 times more abundant along the edge compared to 10 m into the reef. In contrast, the damselfish *Pomacentrus moluccensis* was seven times more abundant 10 m into the reef compared to the edge. Coral genus richness did not differ between the edge and reef habitat, however coral cover was higher on the reef compared to the edge. These findings suggest that edge effects are prevalent on reefs. Future research should focus on experimental approaches to determine the mechanisms driving edge responses, as this will improve our understanding of the impacts of habitat fragmentation on coral reef assemblages.

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RECONSIDERING THE ECOLOGICAL IMPACTS AND SOCIAL CONSEQUENCES OF INVASIVE LIONFISH (Abstract ID: 29702)

Globalization, climate change, and other influences have accelerated the rate at which species invade and re-shape ecosystems. However, in the ocean there are few examples of successful invasions by vertebrate predators. A conspicuous exception is found in the Western Atlantic, Caribbean, and Gulf of Mexico, where the Indo-Pacific lionfish (Pterois volitans/miles) has become firmly established with unprecedented speed. There is a near universal call to reduce the abundance of lionfish, as their ecological impacts on native populations are thought to be enormous. We propose a deeper consideration of the lionfish invasion, by (i) identifying research gaps with respect to lionfish population and community dynamics, especially in the context of the huge geographic range over which the invasion has occurred; (ii) presenting data suggesting that lionfish impacts on native prey and predators may not be that different than those of native mesopredators released from predation, perhaps due to overfishing of apex predators like sharks and large groupers; and, (iii) reviewing socio-economic arguments for encouraging dive tourism centered on lionfish, raising awareness of environmental issues through the lens of the lionfish invasion, and for providing food to tropical developing countries by facilitating sustainable lionfish fisheries. We close with a call to action to reconsider place-based management of lionfish that is best suited to local social and ecological needs.

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DISENTANGLING ECOLOGICAL AND ANTHROPOGENIC DRIVERS OF CORAL REEF FISH POPULATIONS IN THE WESTERN INDIAN OCEAN (Abstract ID: 29415)

Understanding the primary drivers that determine fish species assemblages on coral reefs is vital for effective conservation planning. However, separating factors that are natural, such as habitat requirements for juveniles fishes, from anthropogenic, such as fishing and climate induced coral bleaching, is challenging. The western Indian Ocean (WIO) represents a region of highly variable coral reefs ranging from shallow fringing reefs on the east African mainland to steep volcanic reefs in Comoros to turbid low relief reefs in north-east Madagascar. The abundance and size structure of over 140 species of coral reef fishes were measured together with a range of benthic and reef structure variables at over 100 sites in four countries of the WIO to examine correlates of fish species assemblages. Reef geographic location, structure and benthic composition all play a primary role in determining reef fish populations irrespective of anthropogenic influences. Principle species driving these patterns come from the acanthurids, chaetodontids, caesionids and scarids. The value of such large scale regional analyses lies in the ability to determine broad scale patterns in reef fish assemblages that can be attributed to natural ecological processes, after which anthropogenic drivers can be examined more closely. This revealed high impact areas related to fishing, areas with low impacts from coral bleaching and areas where protection measures appear effective. Disentangling these ecological and anthropogenic drivers now enables more accurate spatial planning to maximise the conservation of reef fish populations in the WIO.
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EFFECTS OF AN ATYPICAL RAINFALL SEASON IN THE ACROPORA PALMATA POPULATION OF THE SIAN KAAN BIOSPHERE RESERVE (Abstract ID: 29905 | Poster ID: 477)

Due to the ecological importance of coral Acropora palmata during 2011-2013 we did an identification and characterization of the patches found at the Sian Kaan Biosphere Reserve (SKBR) for restoration purpouses. We found 24 high density patches (more tan 50 colonies grouped) distributed along the reef crest: 5 in the North, 13 in the Center and 6 in the South. Evaluation of condition and host and zooxanthella genotype identification was done for a sample of the patches found. During this period the population of Acropora showed an apparent stability in terms of changes in density and conditions of the colonies. Living tissue was higher than 80 percent with scarce recent mortality or other impacts. However by the end of 2013, the area was affected by an atypical rainfall season. High density patches were evaluated during 2014. Results showed more tan 70 percent of the patches affected in the center section and 30 percent in the south. Average living tissue inside the patches decreased 10 percent. Recent mortality increased in all sections: seven high density patches were found with 90 percent of colonies dead only in the central section. Although high genotype diversity was found in the area, the central section showed the lower values compared with north and south. Among the patches with higher survival, different combinations of symbiont and host genotypes were found. Looking at the different climate change related events it is then important for restoration programs to maintain higher diversity avoiding selection of specific genotypes to increase resilience.
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LATITUDINAL DISCONTINUITY IN CORAL SYMBIOSES HAS THE POTENTIAL TO LIMIT SPECIES MOVEMENTS UNDER CLIMATE CHANGE (Abstract ID: 28878)

Perhaps the most significant marine symbiosis is that between reef building corals and dinoflagellates of the genus Symbiodinium. The ability of corals to thrive in specific habitats depends on the combined tolerance range of both symbiotic partners. Given the emerging migration of coral species from the tropical into higher latitudes under climate change, it is surprising that little information exists on symbiont diversity at higher latitudes and the processes defining species range margins for both symbiotic partners remain largely unknown. Here, we examine species composition of coral-symbiont associations amongst nine high-latitude coral communities along the eastern Australian coast and compare these to tropical GBR symbioses. A comparative community analyses is used to detect whether biogeography or environmental factors influence species boundaries. Compared to the GBR, symbiont diversity among high latitude coral communities was relatively high. Host generalist and specialist symbionts were common, yet these were genetically distinct from tropical symbiont species. Importantly, some coral species exhibited significant latitudinal discontinuity in their associated symbionts, indicating that local adaptation and/or genetic isolation of symbionts is common at high latitude locations. While it is unknown whether the observed breaks in symbiont species assemblages are due to dispersal limitation, adaptation under natural selection, or speciation, significant genetic discontinuity of symbionts within a coral species might restrict movement outside current range margins.

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ASSESSING HEALTH OF MASSIVE *PORITES* SPP. IN THAI WATERS (Abstract ID: 29409 | Poster ID: 418)

Coral diseases are associated with both anthropogenic and natural stressors such as sediment from coastal development, excess nutrients, pollution, and competition with

macroalgae and reef benthic animals. The purpose of this study was to assess coral health by detecting prevalence of coral diseases on massive *Porites* in twenty two study sites covering the Eastern, Inner, Western Gulf of Thailand and the Andaman Sea during 2010 – 2015. High incidence of all coral diseases was found at Ko Khang Khao, Ko Nok, Ko Sak, in the inner Gulf of Thailand, Ko Samet and Ko Kudi in the eastern Gulf of Thailand, Ko Thai Phlao, Ko Sam Sao in the western Gulf of Thailand, Ao Thaimuang, Ko Surin Nua, Ko Rawi, and Ko Butang in the Andaman Sea. The major patterns of coral diseases in Thai waters consisted of pigmentation responses (pink lines, pink patches, pink spots, pink borers), white syndromes (white patches, white bands, ulcerative white spots), growth anomalies, fish bites and unusual bleaching patterns. Pink borers and white patches were the most prevalent disease at Ko Thai Phlao and Ko Sam Sao in the western Gulf of Thailand. Fish bites were mostly found at Ao Thaimuang, Ko Surin Nua, Ko Rawi and Ko Butang in the Andaman Sea. Poor water quality, especially with high nutrients and organic carbon, may link to high incidence of coral diseases in the Gulf of Thailand. This study supports evidence that higher coral disease prevalence is linked to anthropogenic disturbances on coral communities in Thai waters.

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STUDY OF CORAL REEF ASSOCIATED MARINE BENTHIC POLYCHAETES IN THE MARINE NATIONAL PARK IN THE GULF OF KUTCH, GUJARAT, INDIA. (Abstract ID: 28651)

This study aims at understanding the ecological values of the coral reef and marine benthic polychaetes ecosystem at the Marine National Park in the Gulf of Kutch, Gujarat State, India. Polychaetes are highly abundant and/or diverse in most marine habitats, especially such benthic communities as soft sediments, algal turfs and fouling communities. For this, research environmental study has been carried out at the Okha and Vadinar, which is the prime area of the Marine National Park. The results of the study indicate that a total of 20 species belonging to 13 families was recorded at both study station. During the post-monsoon study period-2014, Nephthys oligobranchia, Lycastis indica, Capitella sp., Diopatra neapolitana, Glycera alba, Spirographis sp., Prionospio pinnata and Maldanides were the common species recorded in the study region. The less common species like Onuphis investigatories, Glycera lancadivae, Nereis cricognatha, Amage bioculata, Magelona sp. and a very rare species from the family Pontoderidae namely Pontodora pelagica were encountered during pre-monsoon-2015 period. Magelona cincta was the common, while the Capitella sp. was the dominant species. Seasonal changes do not seem to have much impact on the benthic polychaetes faunal abundance and diversity in the Coral reef vicinity. The study reveals that Hydrological and Sediment factors are most influencing abiotic factors in species diversity in the study area of the Gulf of Kutch Gujarat, India. Key words: Coral reef, Benthic, Polychaetes, Gulf of Kutch, Gujarat.
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DISEQUILIBRIUM - IMPLEMENTING REEF MANAGEMENT STRATEGIES IN A WORLD OUT OF BALANCE (Abstract ID: 30090 | Poster ID: 404)

This analysis focuses on current issues in the field of coral reef conservation from perspectives of policy-based reef management, highlighting prominent biotic, abiotic and combination interactions that have driven changes in our modern environmental equilibrium. Historical attempts at local approaches are referenced to suggest the need for updated guidelines, strategies and a proposed globally-based support system of coastal reef management, mitigation and conservation. Many current practices in this sector are either outdated, inaccurate in basis or both. Site-specific implementation of monitoring and surveillance objectives provides a non-biased approach to separately addressing local, regional and global ecological stressors. Managing these stressors at varying spatial scales must prioritize interactive effects – either synergistic, antagonistic or additive in nature. Within isolated, underdeveloped and uneducated coastal regions of the world, colloquial lifestyles and social practices lack the modern social and scientific connectivity required to create conservation connectivity frameworks. These collectives (i.e. marine protected areas and marine reserve networks) facilitate integrative data network monitoring systems and aid reef-neighboring nations by updating perspectives and knowledge of current reef spp. and Scleractinian biodiversity. Maximizing local conservation strategies will establish benefits to local, regional and global ecosystem health and coastal human populations alike.

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CORAL REEF RESPONSE TO RAPID SEA-LEVEL RISE DURING THE LAST DEGLACIATION: NEW EVIDENCE FROM THE DROWNED REEF TERRACES OF WESTERN HAWAII (Abstract ID: 29160)

Fossil reefs are valuable recorders of glacio-eustatic sea-level changes, providing key constraints on last deglacial meltwater pulses (MWP). Determining the timing, magnitude, rate and meltwater source of these rapid sea-level rise events has important implications for understanding ice sheet dynamics and abrupt climatic change. Several global records span MWP-1A, but no consensus has been reached on the precise details or its impact on reef growth. The Barbados reef record initially suggested MWP-1A occurred between 14.2-13.8 ka but subsequent studies from Hawaii and Tahiti suggest it occurred ~500 years earlier at ~14.7 ka. To further investigate MWP-1A and the drowned reef terraces of Hawaii, a SCUBA diving field campaign was conducted off Kawaihae to recover samples down to -150 m. We report eight new radiocarbon ages and corresponding laser ablation inductively coupled plasma mass spectrometry U-Th ages, which are interpreted within the context of all available published dates, to better constrain the timing of reef drowning around Hawaii. Detailed sedimentological analysis and sample vetting were employed to identify key indicators of paleo-sea level, and standardized paleoenvironmental interpretations of coralgal assemblages and drowning signatures were made. These data are integrated with dive observations and mapping data, revealing that the backstepping terraces are multi-generational features with sea level acting as a primary control on their complex evolution. We conclude that the age of Hawaiian reef drowning is consistent with a ~14.75 ka onset of MWP-1A.

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ARE MESOPHOTIC CORALS AND OCTOCORALS REALLY THAT DIFFERENT? AN EVOLUTIONARY PERSPECTIVE FROM CARIBBEAN REEFS (Abstract ID: 29581)

Mesophotic coral reef communities are usually below recreational SCUBA diving but too shallow for deep-sea vehicle exploration. This study aimed to provide a systematic exploration of the mesophotic zone (40-120 m) in an oceanic barrier reef complex in San Andrés Island and on banks along the Deep-sea Corals National Natural Park. Using CCR/Trimix, we wanted to determine whether the mesophotic corals and octocorals comprised unique evolutionary lineages carrying particular traits. We reconstructed molecular phylogenies for both coral (ITS2) and octocoral (mtMutS) species down to 120m and identified their symbiotic microalgae, if present. For both, we found an abrupt lineage/community replacement where zooxanthellate species disappear and azooxanthellate species dominate. We documented this replacement occurring shallower for octocorals (~60m) than corals (~90m). Some reef-building corals, notably Agaricia undata and Madracis senaria, distribute well into this zone (~80m) and are characterized by an increased presence of the endolithic algae Ostreobium, which is notable at the colony surface. Shallow coral communities are replaced by unrelated azooxanthellate cup corals also associated to Ostreobium. For octocorals, younger species lineages are replaced by older lineages characterized by phylogenetically dispersed species, which have thinner branches and smaller polyps than the shallow-water species. Our results suggest that the lower-mesophotic corals and octocorals (>60m) are old lineages related to deep-sea species, whereas upper-mesophotic (<60m) species are young species in response to deep-related ecological divergence.
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THE STRUGGLE FOR EXISTENCE -- HOW COMPETITION REIGNS, ESPECIALLY WHEN PREDATION ABOUNDS (Abstract ID: 29907 | Poster ID: 2)

The seminal work of Gause and colleagues led us to consider the prominent role of competition in constraining the development of communities. When considering pairwise combinations of similar species in a closed environment, one species will exclude the other in the so-called "struggle for existence". In nature, though, we observe quite the contrary with countless species coexisting, challenging the strength of competitive dynamics in regulating community structure. Our group has been considering how complex ecological communities are organized, focusing on highly-diverse coral reef ecosystems and exploiting natural experimental conditions linked with human harvest and manipulation across replicate coral reef ecosystems (islands of the central Pacific). By including relatively untouched coral reef ecosystems as ecological end-members

into the study, we have identified the profound importance of predator-prey dynamics in structuring communities. Critically, within the context of intensive predation we find a complementary increase of competitive dynamics -- both with prey competing with prey and predators competing with predators. These observations lead us to consider a new framework in which Gause's "struggle for existence" is brought into increasing focus in well-developed ecological communities, and in which predation and competition are synergistic processes that lose their rhythm as the trophic structure of ecosystems is perturbed.

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PRIMARY PRODUCTION AND NITROGEN FIXATION OF ENDOLITHIC ALGAE ASSOCIATED WITH THE MASSIVE CORAL *PORITES LUTEA*(Abstract ID: 29008 | Poster ID: 96)

The symbiotic zooxanthellae mainly contribute with photosynthetic products for the nutrition requirements of host. During bleaching event, some corals can survive from stress condition when they lose their zooxanthellae. It was suggested that the biological activity of endolithic algae living within coral skeletons might be an alternative source of energy and food during bleaching events. However, there are few studies on possible translocation of photoassmilates to coral polyps. Therefore, we wanted to investigate the contribution of endolithic algae associating with *Porites lutea* by examining primary production and nitrogen fixation by incubation experiments using $^{13}C$ and $^{15}N$ tracer techniques. We want to discuss possible translocation process between endolithic primary producers and the host. Three conditions (control, partially bleached coral and healthy coral) were used during *in situ* incubation at Sesoko beach, Okinawa, Japan. Primary production of endolithic algae was the same order of magnitude to those of coral polyps. Nitrogen fixation that occurred during the day and also during the night showed that heterocyst possessing cyanobacteria are important components of the endolithic community.

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REPRODUCTIVE PLASTICITY OF THE SCLERACTINIAN CORAL ACROPORA HYACINTHUS LIVING IN DIFFERENT TEMPERATURE ENVIRONMENTS (Abstract ID: 28494 | Poster ID: 38)

Previous studies often linked the delay of coral spawning timing to decreasing seawater temperatures at higher latitudes. However, it is still not clear whether the shift in coral species' spawning timing is caused by either genetic divergence or phenotypic plasticity of corals to local temperature environments. This study focused on examining reproductive plasticity of different populations of the broadcast-spawning scleractinian coral Acropora hyacinthus, living in different temperature environments. Considering traits that are crucial determinants of fertilization success and post-settlement performance, plasticity in reproductive timing and polyp-fecundity (e.g., egg-size, testis-size, total gamete vol.) were examined during 2015–2016 through a reciprocal transplantation experiment between southern and northern coasts of an islet (Lyudao) located in southeastern Taiwan. Additionally, intraspecific variation and plasticity in polyp-fecundity were compared during 2014–2015 among populations at six latitudinal locations [Japan (32˚N), Taiwan (22–25˚N), and Indonesia (6˚S)]. We specifically expect larger egg-sizes and a delay in spawning timing at the colder-areas (higher latitude), demonstrating significant reproductive plasticity among populations living in different local temperature environments. The results of the present study will provide new insights into coral reproductive strategies and plasticity in response to different seawater temperatures.

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DEVELOPING THE BIOLOGICAL CONDITION GRADIENT (BCG), AS A TOOL FOR DESCRIBING THE CONDITION OF US CORAL REEFS (Abstract ID: 28397)

Understanding effects of human activity on coral reefs requires knowing what characteristics constitute a high quality coral reef and identifying measurable criteria. The BCG is a conceptual model that describes how biological attributes of coral reefs change along a gradient of anthropogenic stress. The BCG provides a framework using qualitative and quantitative reef attributes to determine current coral reef conditions. Experts in coral reef organisms (coral, fish, sponge, gorgonian, algae) developed a BCG model for Puerto Rico. The model describes the full range of biological conditions resulting from human disturbance, including community structure, organism condition, ecosystem function and connectivity. Each condition level is defined and grounded in natural biological integrity. Levels contain a detailed narrative and process for translating specific metric scores. Reference condition is a natural fully-functioning coral reef that serves as a non-shifting baseline and established through expert consensus. BCG levels can be aligned with designated aquatic life uses specified in water quality standards and used for protection and potential restoration of coral reefs. Managers can use the BCG model to define biological integrity grounded in natural condition, assess current conditions relative to high quality coral reefs, track changes in condition as responses to management actions, and communicate environmental condition and outcomes to the public. The BCG model will be broadly applicable to Caribbean reefs, and the process is transferable to other oceanic regions.

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REVEALING THE MURKY HISTORY OF THE CORAL TRIANGLE (Abstract ID: 29339)

New studies on the fossil record of Late Cenozoic corals from Eastern Borneo have revealed that the first coral assemblages that occurred in the region were mainly low-relief patch reefs. These ancient reefs developed under marginal environmental conditions of low light and high sediment inputs that we interpreted as shallow turbid habitats. Conversely, these marginal habitats hosted a high coral diversity with 100 morphospecies of 55 genera in the Oligocene and 234 morphospecies of 79 genera in the Miocene. The fauna was dominated by platy growth forms of the genera *Porites*,*Cyphastrea*, and *Leptoseris*. We found no significant faunal turnover at generic level within the studied time interval as 85 percent of genera were already present by the early Miocene. Diversity trends through time at species level appear more dynamic, but detailed taxonomic work is still required to provide a complete picture of species turnover in the region. For example, our taxonomic revision of *Acropora* fossils uncovered 31 species including 23 extant species with their first occurrence in the Neogene. Preliminary comparisons of ancient turbid reefs with analogous modern habitats of Eastern Borneo show similarities in richness and faunal composition with dominance of platy corals of the family Agariciidae, foliaceous *Porites* and abundant plate-like colonies of *Acropora elegans*. Our observations suggest that turbid reefs have played an important role during the origination and maintenance of coral diversity in the Coral Triangle.

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ROLE OF THE CORAL HOLOBIONT IN NITROGEN REMINERALIZATION WITHIN DIVERSE CORAL REEF ECOSYSTEMS (Abstract ID: 28166)

Efficient nutrient recycling is thought to be a major factor in the maintenance of high productivity in coral reef ecosystems. The specific mechanisms and locations of nutrient recycling within these ecosystems, however, are poorly described. We used stable isotope tracers (15N) in coral microcosm incubations to determine rates of nitrification, the oxidation of ammonia ($NH_3$) to nitrate ($NO_3$-), associated with stony corals from the genera *Porites* and *Orbicella*. Incubations were conducted in three divergent reef ecosystems: the Micronesian archipelago; Gulf of Batabano, Cuba; and the lower Florida Keys reef tract, with 13 individual coral colonies. We detected nitrification associated with both *Porites astreoides* and *Orbicella faveolata* corals. In contrast to high nitrification rates associated with corals, rates in the waters surrounding the reefs were at or below detection limits. Molecular screening of coral tissue and mucus for the ammonia monooxygenase gene (*amoA*) indicated the presence of ammonia-oxidizing archaea, but not betaproteobacterial ammonia-oxidizing bacteria. Interestingly, several colonies showing high rates of nitrification did not screen positive for known ammonia-oxidizing organisms, suggesting the presence of novel nitrifiers not detected with current methods.

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3D MAPPING OF SEABED BATHYMETRY USING TEARDROP AND SIDESCAN SONAR (Abstract ID: 29239)

The deterioration of marine ecosystem is a growing concern which calls for regular monitoring and assessment. High-resolution underwater cameras attached to towable platforms such as Teardrop (ICRS 2012) are popularly used to gather and archive underwater images, but during low visibility, hours of data gathering become useless. Nowadays, commercial sidescan sonars that can provide depth and seabed topography have become affordable. Although sidescans are not affected by underwater visibility, the lack of other visual information causes uncertainty. For example, if a protrusion is detected by the sonar, it is difficult to identify if the structure is a coral colony or a boulder. In this work, we propose a technique that combines the topographic output of a sidescan sonar and the visual output of the Teardrop imaging platform to create a 3D map of the seafloor where benthos can be identified. Visual analysis of sidescan sonars can establish a 2D to 3D relation to generate 3D maps. Algorithms to align structures seen in sonar with features seen in video were developed. Since the sonar and Teardrop outputs are geo-referenced individually, data from both units may not be simultaneously taken. This can be very valuable when weather conditions do not permit the capture of either data. Three-dimensional mapping of seabed allows faster analysis of the topography's influence to coral distribution and habitat suitability, while images from Teardrop enable diverless monitoring of coral reefs. The proposed technique is a promising tool for rapid assessment of marine habitats.

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VERTICAL DISTRIBUTION OF MEIOFAUNA IN THE NEARSHORE NON-REEF INTERSTITIAL ENVIRONMENT GULF OF KACHCHH GUJARAT INDIA (Abstract ID: 29431 | Poster ID: 661)

The composition and distribution of the benthic meiofauna conglomeration of the Mundra coastal subtidal waters along the Gulf of Kachchh Sea are described in relation to abiotic variables. Sediment samples were collected seasonally from three stations chosen along the vicinity of Adani Power Limited Mundra, sea intake, outfall nearshore and control as offshore regions to observe the meiofaunal community structure, its temporal distribution and vertical fluctuation in relation to environmental conditions of the nearshore marine ecosystem. The temperature, salinity, pH, dissolved oxygen, BOD, nutrients and chlorophyll and Phaeophytin were measured at the time of collection. The water content of the sediments, total organic matters and chlorophyll -a and Phaeophytin values were determined, and sediment samples were subjected to granulometric analysis. A total of 12 meiofauna taxa were identified, with the meiofauna being primarily represented by nematodes, foraminifera harpacticoids, polycheates and ostracodes; and the meiofauna abundances ranging from 21 to 275 individuals/10 square-cm. The meiofaunal population density variation seasonally with high density during pre-monsoon, at all stations. The vertical zonation in the distribution of meiofaunal community was significantly correlated hydrography, chlorophyll a, Phaeophytin and total organic matter values. The present study indicates the existence of the well diversified meiofaunal group which can serve as food for higher trophic levels in the Gulf of Kachchh interstitial coastal environment.
http://www.adanipower.com

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SYSTEM THINKING TO SUSTAINABLE CORAL REEF MANAGEMENT FOR ACHIEVING REGULATORY COMPLIANCE: CASE STUDY OF CORAL TRIANGLE IN INDONESIA (Abstract ID: 28512 | Poster ID: 565)

Despite serious attention on conserving coral reef ecosystem in Indonesia, blast fishing is still rampant which threatens the state of this ecosystem. However coral reef ecosystem is a very complex system which involves various stakeholders with different interests and intentions therefore it needs appropriate approach to assist government in managing this environment sustainably. A system thinking approach through system dynamic modeling could be an alternative tool for communicating among stakeholders to understand the dynamic complexities and the interrelations between key variables by developing a mental model (causal loop diagram) and quantitative model (stock flow diagram) that describes positive and negative polarities, as well as balance and reinforcing loops. The model shows that compliance is not only driven by basic deterrence approach through performing certainty and severity of enforcement but also driven by moral obligation, social influence, and public perception on legitimacy of enforcement authorities. However the model needs to be simulated and tested in further research by using real data thus it can be improved and finally utilized for setting up better policy interventions and avoiding any unintended consequences.

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CORAL REEF RECOVERY 2015: A DECADE AFTER AN EARTHQUAKE ON NIAS ISLAND , NORTH SUMATERA, INDONESIA (Abstract ID: 28351 | Poster ID: 210)

Nias is an island in Indian Ocean off the west coast of Sumatera. In 2005, an earthquake measuring 9 on the Richter Scale hit the island. Much of the island, particularly the coastal ecosystem like coral, seagrass and mangrove, was damaged or destroyed. The earthquake lifted the seafloor up three meters to the surface and added about 100 hectares of new land. The objective of this study is to determine the extent of the recovery of coral reefs there, a decade after the massive earthquake. Fieldwork was carried out annually from April 2004 until September 2015 in eight permanent stations. Line Intercept Transect (LIT) and Underwater Photo Transect (UPT) methods were used to collect biotic and abiotic data from each station. The observations showed that coral coverage in 2004 was 48.31% and monitoring one year after the earthquake in 2005 showed the coverage was 21.39%. Coral recovers slowly. In 2015, the coral coverage was 26,76% and it was in a fair condition. However, the coral coverage was still only 44,60% of that prior to the massive earthquake. It is not surprising that the process occurs slowly because coral reef is a vulnerable ecosystem which is easily influenced by environmental factors as well as human activities. Nevertheless, branching coral of Acropora was recovering well in several sites.

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SPERMONDE ISLANDS AND CORAL REEF FLATS MORPHOLOGICAL DYNAMICS (Abstract ID: 30048)

It was necessary to understand the dynamics of the Spermonde islands in which the future growth or demise of these islands may have important impacts and influence human development of the areas. Area studied was covering more than 40 islands plus submerged coral reefs. Land-sat images of islands and including the reefs surrounding them were collected from 1978, 1990, 2001 and 2010 (NOA-free website. Evaluation of island morphology and coral reefs changes were done through correction of the land-sat images using software Arc View and analyzed to determine the area changes of the islands and reef flats over time. The ratio of island and reef flats area was analyzed using Lyzenga formula. The area of each island and its reef flats was measured, and compared over years. Spatial analysis of satellite images allowed for calculation of area changes from the most loss of 1.46 ha to the most gained of 1.07 ha. Periods of islands decline by 2010 may seems correspond with the passage of recently recorded storms in 2008 to 2010. As for the reef flats the highest lost area is occured in Bonetambung islands up to 9.38 ha, followed by Kulambing with the lost of 8.9 ha. Mass coral bleaching during the early 2009 to mid 2010 seems could contribute to abrasion and accretion processes of the islands although the impact has not yet shown. This research found some of Spermonde islands are already experiencing area lost, both the island and the reef flats, hence potential to become uninhabitable.

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GULF OF KACHCHH MARINE NATIONAL PARK, INDIA, A POTENTIAL CLIMATE-CHANGE REFUGE FOR CORALS (Abstract ID: 29341)

Gulf of Kachchh, the northern most reef region of Indian ocean is the grossly and wrongly under rated reef environment, probably due to low scleractinian coral diversity, total disappearance of branching corals and turbid waters. Qualitative, quantitative and status studies carried out by Zoological Survey of India since 2001 reveal the fact that the biophysical status of Kachchh reefs is on par with other reef regions with an average live coral percentage of about 31%, 45 extant Scleractinian coral species and 800 associated species including the endangered marine mammal Dugong dugon. Scleractinian species of Kachchh are unique, hardy and adopted to harsh semi-arid, sedimented and exposive conditions. The bleaching record of Kachchh is always low to the tune of 10% on an average when compared to about 90% of bleaching reported in other reef regions. The Coral Restoration Project of ZSI under ICZM project of Ministry of Environment, Forests and Climate Change has brought out new findings enhancing the value of Kachchh reefs to the tune of identifying them as 'Climate-change refuges'. 4 species of Staghorn corals brought from Gulf of Mannar and transplanted in Kachchh survived well even in 2014, the hottest year while the mother colonies at GOMBR bleached. Branching corals, disappeared 10,000 years back are now growing well in the waters adjacent

to Mithapur, an industrialised area. The value of Kachchh in terms of its resilience, diversity, tourism potential, biophysical and bleaching status in relation to climate change is discussed in detail in this work with the listing of potential threats and strategies for the conservation of reefs and associated fauna.

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RESTORATION OF EXTIRPATED SCLERACTINIAN CORALS IN TURBID ENVIRONMENT AT GULF OF KACHCHH, INDIA – A SUCCESS STORY (Abstract ID: 28656)

Gulf of Kachchh, the northern most limit of coral distribution in the Indian Ocean, inhabits temperature tolerant and most adopted residual coral species. Up-liftment of tectonic plates of the Gulf and transgression of sea levels made all branching corals to extirpate. Semi-arid conditions, large semi-diurnal tidal amplitude, coral exploitation in the past, high sedimentation, industrialization and anthropogenic activities degraded the reefs and hampering the resilience and recovery capacity of the reefs. During 2013-2015, a total 1000 sq. m. area was restored in 3 spatially distinct sites, along the Southern Gulf using jeopardized native coral species and branching coral species brought from Gulf of Mannar, about 2600 km. far. Site specific innovative and modified restoration methods and modern technologies including remote-sensing were used in each and every step of reef rehabilitation. Maximum survival rate of native coral transplants has been recorded in Pirotan (97.24%) and minimum in Narara (96.50%). Likewise maximum survival rate of branching coral species has been observed in Mithapur (85.25%) and was least in Pirotan (68.75%). Among the native transplants, Cyphastrea serailia recorded highest mean extension rate followed by Porites lichen (5.81±2.12 cm/yr and 5.42±1.25 cm/yr respectively). Among branching coral transplants, Acropora formosa and A. intermedia recorded highest mean extension rates (8.04±1.17cm/yr and 7.13±1.84 cm/yr respectively). Damming reduced sedimentation and site specific strategies are the prime reasons for restoring 10,000 years back extirpated staghorn corals successfully in the Gulf.

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COMMUNITY-BASED RESILIENCE AND ADAPTATION TO CLIMATE CHANGE: USING PLA TOOLS TO FACILITATE VILLAGE CLIMATE RESILIENCY IN AMERICAN SAMOA (Abstract ID: 29506)

Coastal communities are particularly vulnerable to climate change due to their proximity to and reliance on the ocean. Fostering climate resiliency requires an approach that can inform community members about potential climate impacts, obtain community input, and work to turn community needs, priorities, and ideas into actionable items. Participatory Learning and Action (PLA) is one such approach that is well suited to community climate vulnerability assessment and adaptation planning. PLA is a bottom-up approach that aids in gathering information using a diverse range of activities and tools to facilitate participation of local people to strengthen their capacity to engage, learn, and act. Through this approach, the community has the opportunity to learn about key issues regarding their local resources and environment and subsequently implement appropriate strategies to meet those needs. Communities take ownership in the process and the implementation of actions proposed in their resiliency plans. The village of Amouli, a coastal community in American Samoa, used a participatory process in 2011, strengthened by local scientific studies, to develop a village climate resiliency plan. Through the use of PLA tools and modeled results, the village predicted climate impacts were likely to have significant implications on village livelihoods. Aunu'u and Vatia are the most recent village communities that have been engaged in community resiliency outreaches through PLA tools to ensure broad community participation and understanding on potential issues of climate change, with the ultimate goal of building community resiliency and adaptation towards climate change impacts.

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A TRIAL OF IMAGING SONAR SYSTEMS IN COMBINATION WITH STEREO-VIDEO CAMERAS (Abstract ID: 29342)

In waters with varying visibility levels, such as macro-tidally affected reefs, sampling of fishes is challenging using visual-based census techniques. A number of imaging sonar systems have evolved that may be applied to sampling fishes in such waters. We evaluated the relative abundance and length measurements of fishes recorded using four imaging sonar systems in combination with Underwater stereo-Video. The imaging sonar systems trialled (Kongsberg M3, Sound Metrics DIDSON, Teledyne BlueView, and Tritech Gemini) differ in specifications including frequency, range, beam pattern and power. Laboratory comparisons of length measurements using fishes of known length were carried out at the Australian Centre for Applied Aquaculture Research in Fremantle, WA. That study showed that each imaging sonar system measured consistently, but that corrections may need to be applied to gain accurate length measurements. Field comparisons with Baited Remote Underwater stereo-Video (stereo-BRUVs) were carried out in seagrass habitat in Cockburn Sound, WA. While it was not possible to differentiate similarly sized species from the sonar footage, the relative abundance by size class estimates were similar between the imaging sonar and stereo-video recordings. Each imaging sonar system had advantages and disadvantages, with greater image resolution gained at the expense of depth of field. A combination of baited imaging sonar and stereo-BRUVs has great potential for increasing the value of the information that can be collected when sampling fishes in areas of variable visibility.

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TECTONIC SUBSIDENCE PROVIDES INSIGHT INTO POSSIBLE CORAL REEF FUTURES UNDER RAPID SEA-LEVEL RISE (Abstract ID: 27803 | Poster ID: 398)

A magnitude 8.1 subduction earthquake over a relatively pristine coral reef in Solomon Islands in April 2007 caused rapid relative sea-level rise of 0.6 m, generating a unique opportunity to examine *in situ* coral reef response to relative sea-level rise of the magnitude (but not the rate) anticipated by 2100. Extent of live coral was measured from satellite imagery in four years before and after subsidence. Ecological data were obtained from microatolls and ecological surveys. The reef was sampled at 12 locations where dense live hard coral remained absent, remained present, or changed from absent to present following subsidence. To identify factors associated with coral response to relative sea-level rise, ecological data (substratum depth, live coral canopy depth, coral canopy height, substratum suitability, recruitment, diversity and *Acropora* presence) were measured at each location. Vertical and horizontal proliferation of coral occurred following subsidence. Lateral expansion of live coral, accomplished primarily by branching *Acropora spp.*, resulted in lower diversity in regions which changed composition from pavement to dense live coral following subsidence. On relatively pristine reef flats under present climatic conditions, rapid relative sea-level rise generated an opportunity for hard coral. However, the species assemblage of the existing reef was important in determining response to sea-level change, by providing previously bare substrate with a source of new coral colonies. Degraded reefs with altered species composition and slower coral growth rates may be less able to respond to climate change-induced sea-level changes. http://link.springer.com/article/10.1007/s00338-015-1365-0

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SEABIRD NUTRIENTS PROMOTE GROWTH AND RESILIENCE OF CORALS: IMPLICATIONS FOR ECOSYSTEM MANAGEMENT (Abstract ID: 29014)

Marine conservation and management tends to focus on connectivity between seascapes to promote ecological connectivity processes, while often overlooking land-to-sea connectivity. Research demonstrates that seabirds are important vectors of marine nutrients to terrestrial ecosystems, but the influence of seabird-derived nutrients on marine ecosystems is less studied. Using a model island ecosystem in Fiji with a long-term marine protected area and adjacent intact watershed, we demonstrate the uptake of seabird nutrients in corals with chemical tracers. This nutrient subsidy increases coral growth and photosynthetic efficiency of a dominant reef-building coral. Complementary laboratory experiments and reciprocal transplant experiments further support our findings that seabird nutrients enhance resilience of coral reefs near seabird roosting sites when there are abundant populations of herbivorous fishes. This research highlights the need to study pristine ecosystems to understand ridge to reef connectivity and the importance of a holistic ecosystem-based approach that integrates marine and terrestrial systems in conservation planning and management.

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SPATIO-TEMPORAL VARIATION OF CORAL GENE EXPRESSION ACROSS 12 LATITUDES AND 2 SEASONS IN THE RED SEA (TEMPERATURE: 21° - 33°C) (Abstract ID: 29327)

The southern Red Sea is one of the hottest coral reef regions worldwide with summer temperatures up to 33°C. This temperature is considered deadly for corals in most other biogeographic regions. Nevertheless, coral reefs are diverse and structurally complex in the southern Red Sea. This makes Red Sea corals an interesting study object in the context of global warming. By understanding underlying mechanisms of coral thermal tolerance in the Red Sea, we hope to increase our understanding on the ability of corals to adjust to ocean warming. Here, we investigated the gene expression of the coral Pocillopora verrucosa in winter and in summer at 6 stations from the northern (Gulf of Aqaba, 28.5°N, 21-27°C) to the southern Red Sea (Farasan Islands, 16.5°N, 28-33°C) using Illumina sequencing. Results are discussed in relation to coral performance, such as photosynthesis, calcification, mucus release and expression of heat shock proteins, as well as to the coral's genetic composition (host's genotype and Symbiodinium clade/type). This study seeks to elucidate the mechanisms behind the exceptional thermal tolerance of corals from this region.

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INVESTIGATING THE ROLE OF EXTRACELLULAR MATRIX GENES DURING TEMPERATURE STRESS IN THE SEA ANEMONE, AIPTASIA PALLIDA (Abstract ID: 29011)

Matrix metalloproteinases remodel the extracellular matrix and play a role in regulating cell proliferation and cell death through either apoptosis or autophagy. We are investigating how increased temperature affects the expression of a MMP as well as collagen in the sea anemone Aiptasia pallida. In addition we are also using rt-qPCR to determine how increased water temperature affects the expression of two stress-sensitive genes (HSP90 and ubiquitin) relative to either the control gene NADH-dehydrogenase 5 (NDH5) or glyceraldehyde-3-phosphate dehydrogenase 1(GPD1). We temperature-shocked anemones for 0, 6, and 12 hours, isolated RNA, converted it to cDNA, and then used qPCR to measure gene expression. MMP and ubiquitin expression relative to NDH5 showed elevation at 6 and 12 hours, however when expressed relative to GPD1, MMP and ubiquitin were elevated at 6 hours, but not at 12 hours, while collagen expression was elevated at 12 hours. These results suggest that temperature is inducing changes in gene expression for MMP and collagen, but it is also affecting the control genes in a manner that was unexpected. Thus, temperature is inducing changes in expression of the control genes NDH5 and GPD1. We are investigating the relative expression of the two control genes and are also investigating whether a third control gene, actin, will resolve these discrepancies. Results from this study will help elucidate the underlying cellular mechanisms of temperature-induced Cnidarian bleaching and yield insight into which cellular pathways are affected by increased water temperature.

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POST-GLACIAL CLIMATE VELOCITY PREDICTS DIVERSITY IN INDO-PACIFIC REEF-BUILDING CORALS (Abstract ID: 30083)

Resilience in the face of environmental change is determined, in part, by a species' ability to adapt to novel climatic combinations, but also in its ability to track its preferred niche across the landscape via dispersal. Examining the response of species and communities to climatic changes from paleontological to modern times may provide insight into their long-term persistence in the future. Here I examine biodiversity patterns on Indo-Pacific coral reefs as a function of modern climate and also the velocity of climate change since the peak of the last ice age 21,000 years ago. I find that the geographic range of most contemporary corals encompasses climatic combinations with no ice age analogue, and that species richness on non-analogue reefs is higher than on analogue reefs. However, the velocity of post-glacial climate change, measured in terms of dispersal distance and the overall magnitude of change, is a significant negative predictor of species richness. In other words, climatically more stable reefs harbor more species than more rapidly changing reefs, possibly as a consequence of lower rates of local extinction over evolutionary time frames. These results indicate that reef-building corals possess the capacity for climatic niche evolution over the course of tens of thousands of years, but are more susceptible to rapid change. This study provides strong evidence that Indo-Pacific coral reefs will be highly vulnerable to the rapid warming predicted to occur over the next century.

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REGIONAL-SCALE EVALUATIONS OF WATER QUALITY AND CORAL REEF CONDITION IN THE INNER GREAT BARRIER REEF HIGHLIGHT CHALLENGES FOR ADAPTIVE COASTAL ZONE MANAGEMENT (Abstract ID: 29325)

A key pressure for the ecosystems of the Great Barrier Reef World Heritage Area is the exposure to runoff from broad-scale land use in the adjacent catchments. Regular assessments of the condition of the marine environment are essential to evaluate the effectiveness of management strategies put in place to address this pressure, and to support adaptive coastal zone management. A 10-yr program of monitoring the water quality and condition of inshore coral reefs clearly demonstrates the cumulative impact of multiple disturbance events, including tropical cyclones, outbreaks of crown-of-thorns seastars, coral bleaching and periods of high river discharge with associated high nutrient and sediment loads. Resultant declines in inshore water quality and coral community condition are broadly consistent over geographic regions and across various taxonomic groups. This demonstrates the importance and broad 'footprint' of runoff within the inshore Reef lagoon. Within a location, responses of coral communities are most obvious during extremes in environmental conditions. The results are examined using the DPSIR framework (driver-pressure-state-impact-response) to highlight i) the complexity of the relationships between river inputs, water quality and coral reef condition, ii) the challenges for evaluating, reporting and applying the monitoring information in a meaningful way in coastal planning and adaptive management, and iii) the expected long timeframes for measurable improvements in the inshore water quality under the current policy initiatives.

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PARTICIPATORY FISHERIES MONITORING PROGRAMS TO SUPPORT LOCAL MANAGEMENT (Abstract ID: 28504 | Poster ID: 728)

With increased understanding of spatial and temporal population variability comes increased responsibility to incorporate this variability into fisheries management. This is unfeasible for many fisheries, especially data-poor ones that are typical of tropical reefs. One solution is participatory monitoring programs where local fishers, scientists, and regulating agencies work together to gather the necessary information to inform local management. These co-developed monitoring programs collect fishery data at the community scale through incorporating local knowledge along with biological surveys including gonadosomatic index (GSI) and histological assessments of reproductive state. Comparisons between community-collected GSI data and histologically accessed reproductive status produced similar results. Therefore, using basic tools such as scales and rulers, local communities can gather and interpret the necessary information to determine the reproductive biology needed for management. Result were shared with diverse resource users to support customary fishing practices through the use of moon calendars, which inform fishers as to the proper times and sizes to catch fishes specific to that location. Additional benefits included increased understanding by fishers of natural cycles in resources, which led to behavioral changes in fishing practices, resulting in greater conservation and management of these resources. Participatory programs like these build trust among groups, increase management capacity, and ultimately lead to more resilient linked social-ecological systems.

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VARIATION OF SYMBIONT DENSITY OR CELL PIGMENTATION OF SYMBIODINIUM CAUSES DIFFERENT EFFECT ON HOLOBIONT PRODUCTIVITY AND ON ITS SENSITIVITY TO CORAL BLEACHING (Abstract ID: 28400)

Drastic changes in coral pigmentation occur during bleaching events but significant reductions may also occur in summer as part of the photoacclimatory response of the holobiont to the combined seasonal fluctuation in light and temperature. Those changes in coral colour result from two underlying causes, 1) the loss of symbionts and 2) the loss of Symbiodinium pigmentation per cell (Ci). As coral bleaching has been defined as a severe loss of coral colour, seasonal coral paling (optimal holobiont acclimation to summer conditions) cannot be always distinguished from bleaching (a dysfunctional symbiosis). Here we present evidence for four Caribbean coral reef-builders that similar changes in coral pigmentation respond to contrasting physiological conditions in the holobiont. Furthermore, we present an allometric analysis of the differential contribution of symbiont density and Ci to holobiont productivity (photosynthesis and calcification) and to the variation of the specific absorption coefficient (a*, m2 chla-1). Our results highlight the relevance of symbiont losses vs. changes in Symbiodinium Ci to set the "tipping point" of this ancient symbiosis, and that these physiological thresholds, which determine coral bleaching, are related to the extraordinary efficiency of Scleractinian corals as solar energy collectors. Understanding the capacity of the holobiont to maintain a minimum population of Symbiodinium under the increasing levels of light-stress that occur during events of elevated temperature, will highlight its particular sensitivity/robustness to global warming.

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CORAL REEF CONNECTIVITY IN THE WIDER-CARIBBEAN: DESIGN OF MARINE PROTECTED AREA NETWORKS (Abstract ID: 27995)

We integrated coral reef connectivity data for the Caribbean and Gulf of Mexico into a conservation decision-making framework for designing a regional scale marine protected area (MPA) network that provides insight into ecological and political contexts. We used an ocean circulation model and regional coral reef data to simulate eight spawning events from 2008–2011, applying a maximum 30-day pelagic larval duration and 20% mortality rate. Coral larval dispersal patterns were analyzed between coral reefs across jurisdictional marine zones to identify spatial relationships between larval sources and destinations within countries and territories across the region. We applied our results in Marxan, a conservation planning software tool, to identify a regional coral reef MPA network design that meets conservation goals, minimizes underlying threats, and maintains coral reef connectivity. Our results suggest that approximately 77% of coral reefs identified as having a high regional connectivity value are not included in the existing MPA network. This research is unique because we quantify and report coral larval connectivity data by marine ecoregions and Exclusive Economic Zones (EZZ) and use this information to identify gaps in the current Caribbean-wide MPA network by integrating asymmetric connectivity information in Marxan to design a regional MPA network that includes important reef network connections. The identification of important reef connectivity metrics guides the selection of priority conservation areas and supports resilience at the whole system level into the future.

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COMPARISON OF BACTERIAL COMMUNITIES ASSOCIATED WITH *AGARICIA LAMARCKI* FROM MESOPHOTIC AND SHALLOW WATER REEFS (Abstract ID: 30104 | Poster ID: 321)

Access to mesophotic reefs provides a unique opportunity to study the holobiont composition in corals across their bathymetric distributions. We aim at characterizing the coral-associated bacterial community profiles of the scleractinian coral *Agaricia lamarcki* in Puerto Rico and U.S. Virgin Islands. *Agaricia lamarcki* attains a wide bathymetric distribution in the Caribbean where it can be found in shallow (5-10) m and mesophotic reefs (80 m). Associations between bacterial communities and coral hosts are generally species specific, however, we hypothesize that shifts will be observed in the bacterial communities associated with shallow and mesophotic corals. We recently sequenced thousands of DNA sequences using Illumina sequencing technology from the bacterial 16S rRNA gene from over 50 samples of *A. lamarcki* tissue. Comparison of alpha and beta diversities and compositions of samples will be made using the Qiime software and differences in phylogenetic composition between depth-differentiated samples will be visualized with heat maps and network representations.

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THE EFFECTS OF ENVIRONMENTAL FACTORS ON BLACKTIP REEF SHARKS, CARCHARHINUS MELANOPTERUS, ON AN INSHORE REEF (Abstract ID: 29292)

Understanding how reef sharks respond to variability in their environment is increasingly important given their vulnerability to climate change. Due to their close proximity to the mainland, sharks resident on inshore reefs are frequently exposed to fluctuating environmental conditions (e.g. high freshwater run-off/low salinity events). However, documented site attachment to coral reefs means movement in response to unfavourable environmental conditions may not be desirable for these species. Passive acoustic telemetry was used to monitor movement and space use of 18 blacktip reef sharks, Carcharhinus melanopterus, on an inshore reef off the coast of Queensland, Australia to define their response to environmental change. Activity space of sharks was modelled against all possible combinations of environmental (wind speed, barometric pressure, rain, salinity and water temperature) and biological (size, sex) factors and compared using Akaike information criterion corrected for small-sample bias. Model results indicated a relationship between shark activity space and salinity with space use increasing with decreasing salinity. Size and sex were also significant factors in the top performing models with larger sharks having larger activity spaces and males using more space than females independent of size. These results show salinity is an important environmental driver of movement and space use for C. melanopterus on an inshore reef and help define how resilient this species is to environmental disturbance and change.

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ARE ALCYONACEAN SOFT CORALS THE 'GLUE" THAT HOLDS A REEF TOGETHER UNDER EXTREME CONDITIONS? (Abstract ID: 29195)

Alcyonacean soft corals are gaining increasing attention in the South West Indian Ocean (SWIO) where they are a significant component in coral communities. Surveys extending from the Chagos Archipelago towards East Africa and down the Mozambique Channel were expected to reveal a biodiversity gradient in their distribution but anomalies have emerged. While alcyonacean biodiversity in the Chagos is high, it is superseded by that at Mayotte, a regional hot spot for corals. A gradient does occur down the Mozambique Channel but another hot spot is found on South African reefs where more temperate alcyonaceans enter the picture. Anomalies are found within this range, with unexpectedly low diversities of Alcyonacea at Reunion, Geyser, Zélée and Glorieuses Island where they have nevertheless adapted to local conditions. The drivers that appear involved in this are turbulence and volcanic substrata at Reunion, greater sediment movement at Geyser and Zélée, and eutrophication with sedimentation at Glorieuses. Increasingly dynamic surf conditions on south East African reefs introduce greater turbulence and sediment movement at higher latitudes. Certain soft corals flourish under these different conditions and can play an important role in reef stability or reef recovery after disturbance. Slow-growing persistent forms provide stability while more rapid-growing species are opportunistic colonisers within the successional community. Are they 'glue' that can consolidate and stabilise reef structures under extreme conditions?

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IDENTIFICATION OF MARINE PROTECTED AREAS FOR CONSERVATION, MANAGEMENT AND RESTORATION OF CORAL REEFS AND CORAL COMMUNITIES IN THE NORTHERN GULF OF MEXICO (Abstract ID: 29759)

The utilization of marine protected areas is an important strategy in the conservation and management of coral reefs and coral communities. The northern Gulf of Mexico contains a range of coral ecosystems including coral reefs, mesophotic coral communities, and deep-sea coral assemblages. In 2015, the Flower Garden Banks National Marine Sanctuary (FGBNMS) initiated a formal process to expand its current boundaries to increase protection of additional reefs, banks and other offshore features of national significance. In order to identify the most important areas of interest, a procedure was developed to systematically determine the resources of highest ecological, economic and conservation value. This study describes the methodology used to identify those areas evaluated in the expansion proposal. The design methodology was based on information derived from extensive public input, expert opinion and over 30 years of science, monitoring and resource management of the region. In 2012, the FGBNMS released a revised Management Plan, containing a recommendation to expand the boundaries of the sanctuary. Building on this recommendation, a range of alternatives was developed that encompassed new and existing biological information, high-resolution topographic data and a variety of socioeconomic factors. Designation of additional MPAs will provide significant protection to important mesophotic and deepwater coral communities and contribute to restoration efforts in the Gulf of Mexico.
http://flowergarden.noaa.gov

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RETENTION OF THERMAL TOLERANCE IN THE INVASIVE FORAMINIFERA *AMPHISTEGINA LOBIFERA* FROM THE EASTERN MEDITERRANEAN AND THE GULF OF AQABA (Abstract ID: 29314)

Observations on the high thermal tolerance of corals from the northern Red Sea have been interpreted as a result of thermal filtering of larvae thousands of years ago. We test the thermal tolerance on the common benthic foraminifera *Amphistegina lobifera* which invaded and dominates now many areas of the Mediterranean. To this end, we conducted a three-week long experiment in a replicated design exposing a "source population" from the northern Gulf of Aqaba and an "invasive population" from the Levantine Basin, to a gradient of elevated temperatures up to 36°C. Both populations and their diatom symbionts were screened genetically to confirm the invader-source relationship. The response of the populations to the temperature gradient was quantified

by monitoring survivorship, growth and photophysiolgical response. Temperature did not influence survivorship, but photochemical results showed that both populations respond in a similar way to the increased temperatures and show reduced photosynthetic dark yields at ≥34°C. Reduced light yields, occurred already between the control (24°C) and the 32°C treatment. We conclude that the invasive population retains their upper thermal tolerance of the source population. The observed tolerance to temperatures exceeding the summer peaks in the Gulf of Aqaba is consistent with observations on the bleaching resistance of local corals.

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SELFING, OUTCROSSING AND SPERM DISPERSAL IN THE SCLERACTINIAN CORAL *GONIASTREA FAVULUS* (Abstract ID: 28702)

Much of what we know about reproductive relationships, such as the ability of some marine invertebrates to self-fertilise, stems from *ex situ* fertilisation experiments and relies on the assumption that laboratory trials adequately reflect processes that are occurring in natural environments. However, this has rarely been tested empirically. Using several newly developed microsatellite markers we assessed the nature of fertilisation *ex-* versus *in-situ* in the hermaphroditic broadcast-spawning coral *Goniastrea favulus* to compare estimates of selfing and outcrossing under natural and experimental conditions. In particular, we tested for the hypotheses that self-fertilisation represents an important reproductive strategy in *G. favulus*and that this species favours non-self over self-fertilisation in situations of sperm choice. In the presence of self and non-self sperm, the *ex situ*-experiments showed high levels of selfing in *G. favulus* (30%), consistent with the known ability of this species to self-fertilise. However, genotyping larvae fertilised under natural conditions revealed low levels of selfing on the reef (< 3%) and multiple paternity. Additionally, a detailed examination of larval paternity suggested sperm dispersal occurred over several meters, with few larvae being fathered by colonies in proximate distance to their maternal colony. Our results demonstrate that the occurrence of selfing in *G. favulus* may have been significantly overestimated in laboratory trials and that laboratory fertilisation experiments may fail to reflect real world conditions.

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AN EXPERIMENTAL APPROACH TO ASSESSING REEF RESILIENCE: PREDICTING THE LIKELIHOOD AND REVERSIBILITY OF ABRUPT CORAL-TO-MACROALGAE STATE TRANSITIONS (Abstract ID: 27905)

Coral reefs can switch abruptly from a coral community to one where seaweeds are a major space holder. Effective means to prevent such a shift or restore the coral state can benefit by knowledge of three issues: (1) how much herbivory is needed to prevent the widespread establishment of macroalgae; (2) where ambient herbivory lies in relation to the minimum needed to retain control; and (3) whether there is hysteresis in the herbivory – macroalgae relationship that would hinder reversibility of the state shift. We developed an experimental approach to answer those questions and applied it to reefs surrounding Moorea, French Polynesia. Our design created a gradient in herbivory, which broadly mimicked the effect of variation in fishing intensity on herbivorous fishes. We found that the shape of the herbivory – macroalgae relationship was highly non-linear, with a sharp herbivory threshold below which seaweeds escaped control. Further, the intensity of ambient herbivory in relation to the tipping point varied among reefs; herbivory at some reefs was far above the threshold while at others it was not. Hysteresis also was evident in the relationship, indicating that it took more herbivory to remove seaweeds than to prevent them from becoming established. We also found that reversibility of the state shift, as indicated by the range of herbivory over which hysteresis was detected, varied among reefs. Our experimental approach can be applied to other reef systems, and as such, it can provide a powerful tool to inform resilience-based management strategies.

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THERMAL TOLERANCE OF CORALS FROM THE NATURALLY EXTREME KIMBERLEY REGION IN NORTHWEST AUSTRALIA (Abstract ID: 27983)

Naturally extreme temperature environments such as the Kimberley region in northwest Australia provide ideal natural laboratories to understand what drives coral thermal tolerance. We will present findings from several lines of research assessing the capacity and limits of Kimberley corals to cope with future ocean warming. A heat stress experiment aimed at establishing bleaching thresholds for nearshore Kimberley corals showed that they were highly sensitive to temperatures exceeding their typical summer temperatures despite being adapted to a naturally extreme temperature environment. However, corals collected from the environmentally more extreme intertidal took longer to bleach and die than corals from the more moderate subtidal environment. Given that all corals harboured*Symbiodinium* clade C independent of treatment or origin, this highlights the importance of the thermal environment in shaping coral thermal tolerance. A reciprocal transplant experiment is currently in place to study over what time scales subtidal corals could acclimatize to the more extreme temperatures of the intertidal and preliminary results will be presented. Our findings have significant implications for the current global bleaching event as the Kimberley region is expected to experience significant bleaching over the next few months, which will be monitored. Overall, the evidence from the controlled tank and field experiments and bleaching surveys will significantly improve our understanding of how corals from naturally extreme environments may cope with continued climate change.

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BIOERODING SPONGES ON THE CENTRAL GREAT BARRIER REEF – A LONG-TERM PERSPECTIVE (Abstract ID: 29190)

Calcifying organisms are predicted to suffer from changing environments, and bioeroder abundances and activities to at least temporarily increase, resulting in reduced reefal calcification and simultaneously in increased bioerosion. As coral reefs are already under significant pressure, this is thought to lead towards net framework erosion, to reduced biodiversity, reef structural strength and framework complexity. Nevertheless, bioerosion is routinely monitored in only a few programs, not studied over large spatial scales in a comparative way, and very few surveys have been repeated over time. Where data are available, sponge bioerosion appears to be increasing over time, largely due to deteriorating water quality or coral mortality. The community of bioeroding sponges at Orpheus Island, central Great Barrier Reef was assessed in 1997/98 before a major bleaching event, then again in 2003/04, when their total abundance had increased to 150% of the original areal cover. A further survey in 2010/11 suggested that the habitat still had not recovered. During this last survey Tropical Cyclone Yasi damaged parts of the reef, but bioeroding sponges showed no signs of being negatively affected. Lateral growth rates of one of the most dominant species, *Cliona orientalis* Thiele, 1900, were found to reach 5 cm yr-1, and its downward bioerosion of framework could amount to 1 mm yr-1. Locally, this species alone is able to erode more than 15 kg m-2 yr-1 and belongs to a species complex that is thought to include sponges that can rapidly unbalance reef carbonate budgets.

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METRICS OF SUCCESS FOR ACROPORA RESTORATION IN THE CARIBBEAN (Abstract ID: 29417)

In-situ coral nurseries and coral gardening methods are increasingly used for the restoration of the threatened staghorn coral, *Acropora cervicornis*. To date, > 65,000 staghorn corals have been outplanted in Florida alone and expanding efforts are now having positive impacts at ecologically relevant scales. Here we: 1) outline key findings from regional restoration programs in Florida and Puerto Rico, and 2) propose benchmarks that can be used to evaluate the success of each step of the gardening process. Our combined data establish that the collection of fragments does not negatively impact donor colonies and that the survival of nursery fragments was >90% over the first year. Nursery corals demonstrated healthy growth (10.3-29.5 cm $yr^{-1}$) with significant variability between genotypes and platform types. Survival of outplanted corals was >80% after 2 years and strong growth was maintained. However, performance of genotypes within nurseries was not always predictive of performance on natural reefs. High survivorship and growth of corals, both within nurseries and after transplantation, demonstrates the effectiveness of nursery and outplanting programs to enhance threatened *Acropora* populations. The benchmarks of success suggested here, based on the careful tracking of thousands of corals, will ensure restoration projects are meeting acceptable goals and promote the

advancement of restoration sciences. Departures from these benchmarks should be assessed and direct the improvement of both nursery and outplanting methodologies and site selection.

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PREDATION AND NUTRIENTS AFFECT THE SUCCESS AND MICROBIOME OF A FOUNDATIONAL CORAL (Abstract ID: 27792)

Elevated nutrients and altered food webs are common threats to ecosystems worldwide. On coral reefs, the impacts of nutrients and herbivory on coral-algal interactions have been extensively documented, yet the role of direct predation and nutrients on corals and their symbionts remains elusive. Here, we assess the effects of predation by a prevalent coral predator (the short coral snail, Coralliophila abbreviata) and nutrient enrichment on staghorn coral, Acropora cervicornis, and its microbiomes using a factorial experiment and high-throughput DNA sequencing. Predation significantly reduced growth, increased mortality and turf algae colonization, and altered the microbiomes of experimental corals. In contrast, nutrient enrichment most strongly affected coral microbial communities, markedly increasing the abundance of a Rickettsia-like organism (RLO) and reducing overall microbial diversity. Notably, this RLO is currently a suspected pathogen of the coral 'white band' disease, and was also found to strongly correlate with reduced growth rates in nutrient-exposed corals. These results show that predation can strongly suppress the success of small corals, while nutrient enrichment may have important, but visually imperceptible, effects on coral health by altering microbiomes. This research has novel implications for understanding the restoration or recovery of corals and the effects of top-down and bottom-up control on foundation species and their associated microbial communities.

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A DECADE OF SUCCESSFUL PARTNERSHIPS THROUGH NOAA'S CORAL REEF CONSERVATION PROGRAM FISHERY LIAISONS IN THE US PACIFIC ISLANDS REGION (Abstract ID: 29016)

Lack of capacity continues to constrain coral reef conservation. For the past decade NOAA's Coral Reef Conservation Program (CRCP) and Pacific Islands Regional Office have supported Fishery Liaisons in the US Pacific. The Liaisons have significantly improved partnerships and technical capacity as they collaborate with and provide direct support to local resource agencies, NGOs, and communities, and integrate NOAA Line Offices in the matrixed CRCP, all to improve fisheries management and conserve reef habitat. Through close agency/public partnerships, Liaisons have helped reduce threats to coral reefs, enhance technical capacity, develop and implement projects, and increase compliance with mandates. The Liaisons' diverse portfolio includes field surveys, permit reviews, and community outreach, which provide unique synergistic benefits in understanding problems and developing solutions across the region. Successes include: culturally attuned village management plans in Am. Samoa; novel scientific reef resiliency studies in the CNMI; establishment of a NOAA Habitat Blueprint site in Guam; and co-coordination for the Pacific Islands Managed and Protected Area Community. The Liaisons' accomplishments highlight the value of strong collaboration and partnership in management efforts, the need for programs to engage and support community-based management, the value of using sound science to improve decisions, the need for sensitivity to and understanding of local issues and concerns, and the flexibility to capitalize on unique Liaison-strengths. Continuing into the future, Liaisons expect to expand efforts to improve reef resilience and facilitate recovery of ESA-listed corals.
http://www.fpir.noaa.gov/

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MULTI-FACTOR ASSESSMENT OF RESILIENCE POTENTIAL OF CORAL REEFS IN THE MAIN HAWAIIAN ISLANDS (Abstract ID: 29754)

Declining health of coral reef ecosystems led scientists to search for factors that support reef resilience: the ability of reefs to resist and recover from environmental disturbance. Expert review of potential factors highlighted eleven that can affect reef resilience. These factors were quantifiable, and included fishing pressure, sea surface temperature variability, pollution and sedimentation from run-off from adjacent watersheds, and characteristics of coral and reef fish assemblages. These factors were used as an analytical framework to conduct a quantitative assessment of the resilience potential of reefs throughout the main Hawaiian Islands (mHI). Locations of Rapid Ecological Assessment (REA) surveys conducted by the NOAA were used to delineate study units, or 'georegions.' REA surveys provided data to quantify biological/ecological resilience factors, while external data sources were used to inform physical and environmental factors. Scores for each factor were normalized and averaged to produce a composite resilience score for each georegion. This reef resilience assessment delineated and compared 29 georegions across the mHI. Composite scores were highest for the northwest Ni'ihau and east Maui georegions, and lowest for the south O'ahu georegion. Factors such as fishing pressure, sedimentation, herbivore biomass and macroalgal cover provided the greatest differentiation among georegions. These factors can all be influenced locally, highlighting potential avenues for targeted, resilience-based management efforts.

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MOLECULAR SIGNATURES OF TRANSGENERATIONAL BRAIN RESPONSE TO OCEAN ACIDIFICATION IN A REEF FISH (Abstract ID: 29226)

The impact of ocean acidification on marine ecosystems will depend on the capacity for species to adapt. Recent studies show that the behaviour of reef fishes is impaired at projected future CO2 levels; however there is also individual variation that might promote adaptation. We used a genome-wide approach to evaluate the potential heritability of this variation in CO2 sensitivity in the spiny damselfish, Acanthochromis polyacanthus. Offspring of CO2 tolerant and CO2 sensitive parents were reared at near-future CO2 (754 µatm) or present-day control levels (414 µatm). By integrating 36 brain transcriptomes and proteomes with a de novo assembled genome we investigated the molecular responses of the fish brain to increased CO2 and the expression of parental tolerance to high CO2 in the offspring molecular phenotype. Exposure to high CO2 resulted in differential regulation of 173 and 62 genes and 109 and 68 proteins in the tolerant and sensitive groups respectively. Importantly, the majority of differences between offspring of tolerant and sensitive parents occurred in high CO2 conditions. Consequently, there was a clear signature of parental sensitivity to high CO2 in the molecular phenotype of the offspring, primarily driven by circadian rhythm genes. This transgenerational molecular signature suggests that individual variation in CO2 sensitivity could facilitate adaptation of fish populations to ocean acidification.

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BIOACTIVE SPONGES OUTCOMPETE SCLERACTINIAN CORALS (Abstract ID: 29803)

In recent years there has been an increasing number of reports that sponges are becoming more abundant and in some regions have become the dominating benthic organisms on coral reefs. Some locations in the Caribbean provide increasing evidence that coral reefs are shifting from coral dominated to sponge dominated reefs. For the Indo-Pacific there are also a number of reports which suggest that sponge biomass and abundance are increasingly correlating with a decline in coral cover caused by anthropogenic effects, such as overfishing, sedimentation, eutrophication as well as climate change. One possible mechanism why some sponges are successful competitors is the production of bioactive compounds. It has been well established that sponges use secondary metabolites to defend themselves against predatory fish and invertebrate predators. Studies on sponge allelopathic compounds are however largely lacking. We investigated crude extracts from 10 sponges collected from Bawe Island, Zanzibar, Tanzania to study the antipredatory effects of the sponges and tested also if sponges produced alleopathic compounds to overcome coral competitors. In addition to evaluating various reef sponges in Zanzibar, we investigated in detail the chemical ecology of a particularly dominating sponge (Pseudoceratina sp.), which we first sighted at Koh Phangan in the

Gulf of Thailand. This sponge was covering large areas of the benthic substrate and overgrew various other invertebrate species including corals. Results from both the feeding and allelopathic experiments will be presented.

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SUSCESPTIBILITY OF ACROPORA PALMATA PATCHES TO THERMAL STRESS (Abstract ID: 28185)

Populations of *Acropora palmata*, a keystone reef-building coral in the Caribbean, have decreased significantly since the 1970s. Currently, its principal threat is increasing seawater temperature associated with global climate change and its relationship to bleaching and diseases. Recently, genetic diversity of the coral host, its symbiont and their combinations has been recognized as a source of functional diversity. Therefore, we selected 9 host-symbiont genotype combinations from each of three patches: La Bocana, Limones and Punta Venado in the Mexican Caribbean to study the variability in patch susceptibility to thermal stress. Coral colonies from these patches are part of one genetic population, while their symbionts belong to three local populations. After a 3 month acclimation to aquarium conditions, half of the fragments were exposed to heat stress (31°C), while the other half remained under ambient conditions (28.5°C) for 17 days. Photochemical efficiency, reflectance and survival were monitored throughout the experiment and used to calculate maximum excitation pressure and absorbance at 675 nm. At the start and end of the experiment, symbiont density, chlorophyll *a* density and skeletal weight were determined. The increased temperature induced cellular and photochemical changes associated with bleaching and reduced skeletal growth rate in all of the coral samples. Fragments from La Bocana appeared to be more susceptible to heat stress than those from the other two sites supporting the notion that genetic diversity is a source of functional diversity.

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INTRACOLONIAL GENOMIC VARIABILITY IN ACROPORA HYACINTHUS (Abstract ID: 29258)

Coral reef degradation is a major economical and ecological concern. Consequently, coral reef conservation is a main goal of environmental protection. To protect reefs effectively, information about the genomic variability of corals is necessary. Population genomic data on coral species are therefore of prime scientific interest. In recent years, the new phenomenon of intracolonial genetic variability within a single coral colony has been described. This connotes that coral colonies do not necessarily consist of only a single genotype, but contain several distinct genotypes. So far only studies based on a few neutral molecular markers (e.g. microsatellites) have been used to identify heterogeneous colonies. However, it is unknown to what extent multiple genotypes within a colony vary genome wide and if they may differ in adaptively important genes. To investigate genome wide genetic variation in corals we used a new ddRADseq protocol that we optimized specifically for Acropora hyacinthus. Preliminary results show a large number of highly variable loci. Colony specific SNPs as well as allelic diversity within the same colony could be detected. Our results indicate that genomic variability in corals is much larger than expected and might influence a colonies' adaptive potential.

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THE IMPACT OF BLEACHING ON REEF FISH SETTLEMENT: DOES NEMO KNOW WHEN HIS HOME IS STRESSED? (Abstract ID: 27809)

Understanding how bleaching impacts the settlement of symbiotic habitat specialists, and whether there is flexibility in settlement choices with regard to habitat quality is essential given our changing climate. We used five anemonefishes (Amphiprion clarkii, Amphiprion latezonatus, Amphiprion ocellaris, Amphiprion percula, and Premnas biaculeatus) and three host sea anemones (Entacmaea quadricolor, Heteractis crispa, and Heteractis magnifica) in paired-choice flume experiments to determine whether habitat naïve juveniles have the olfactory capabilities to distinguish between unbleached and bleached hosts and how bleaching may affect settlement decisions. All anemonefishes were able to distinguish between unbleached and bleached hosts, and only responded to chemical cues from species-specific host anemones irrespective of health status, indicating a lack of flexibility in host use. While bleached hosts were selected as habitat, this only occurred when other options were unavailable, with the exception of A. latezonatus, which showed strong preferences for H. crispa regardless of health. This study highlights the potential deleterious indirect impacts of declining habitat quality during larval settlement in habitat specialists, which is particularly important given that bleaching events are becoming increasingly common.

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EFFECTS OF TEMPERATURE ON *IN SITU* BEHAVIOUR AND ACTIVITY OF CORAL TROUT, *PLECTROPOMUS LEOPARDUS*, ON THE GREAT BARRIER REEF, AUSTRALIA (Abstract ID: 28493)

Physiological performance of marine fishes is highly sensitive to changes in temperature. Spatial and temporal variation in ocean temperatures may have a marked impact on activity and behaviour of fishes thereby influencing population structure and fisheries productivity. This study examines variation in activity and behaviour of common coral trout (*Plectropomus leopardus* ) among seasons and between locations in the northern and southern sectors of the Great Barrier Reef, Australia. *In situ*observations show that routine swimming speeds of *P.leopardus* increase with increasing temperature from 36.1 $cms^{-1}$ ($\pm$ 4.3 SE) at 22°C compared to 40.8 $cms^{-1}$ ($\pm$ 6.5 SE) at 30°C. However, it is expected that high temperatures > 30°C might constrain the frequency and speed of burst swimming, impacting feeding success and energetic intake. Accelerometry data from 38 acoustically tagged *P. leopardus* will be downloaded and analysed in March 2016, providing detailed information on activity budgets of fishes exposed to maximum summer temperatures . This study explores the implications of the effects of increasing temperature on wild stocks of *P.leopardus* These results are complemented by previous tank based studies and will enable better informed predictions about how *P.leopardus* populations and coral reef fisheries generally, might be impacted by sustained and ongoing global climate change.

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SPECIES DIVERSITY CHANGES SINCE 1980 ON BAHAMIAN REEFS SHOWS SHIFTS IN ECOLOGICAL STRUCTURE (Abstract ID: 29663)

Maintaining biodiversity over time is paramount to the functioning of coral reef ecosystems. Species abundance and richness change over time, but overall biodiversity is maintained to support ecosystem services. A decrease in biodiversity can detrimentally impact reefs; potentially phase shifts can fundamentally alter the dominance of stony corals along with ecosystem structure. SCUBA diver photography can form important baseline information on both species and taxa level diversity trends on less-accessible reefs over decades.This may be especially important to understand long-term trends and changes associated with climate change.An assessment of changes in reef benthos was carried out combining researcher and recreational underwater photographs from SCUBA divers beginning in 1980 to 2015. Reefs that were consistently visited in the Exuma Cays Land and Sea Park, The Bahamas were targeted for collecting photographs cataloged by date and dive site. The photography image database provided an exceptional opportunity to study key reef species from 2,963 slides collected on five dive sites from 1980-2015. Changes in reef biodiversity with a focus on cnidarians, sponges and annelids were evaluated with diversity indices and multivariate analyses. Invertebrate diversity showed a decrease in species diversity after 1984, with a slight recovery from 1994-1996, and a steep decline thereafter into 2015; This may be especially important to understand long-term trends and changes associated with climate change.
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SPATIOTEMPORAL VARIABILITY IN MARINE SEDIMENTATION IN ST. JOHN, US VIRGIN ISLANDS AS A RESULT OF RAINFALL AND WATERSHED DEVELOPMENT (Abstract ID: 29055)

Terrigenous sedimentation on coral reefs from watershed development poses a threat to coral reefs. We examined how marine terrigenous sedimentation varied in eastern St. John as a function of: different rainfall parameters (mean daily rainfall, mean rainfall intensity, maximum daily rainfall), wave height, and degree of watershed development. Sediment traps (13) were deployed over ~26-day sampling periods near shore and at offshore reef sites below developed and minimally developed watersheds over five hurricane seasons. Terrigenous sedimentation was greater: during periods of high rainfall (especially high maximum daily rainfall and high 15-min mean rainfall intensity) and/or wave height and below developed watersheds. The relationship between rainfall parameters and terrigenous sedimentation were strongest when an antecedent precipitation index (a proxy of soil moisture) was considered. Terrigenous sedimentation rates at sites below developed watersheds were approximately four times greater than below minimally developed areas, and this degree of impact was generally consistent with watershed erosion models. Based on comparisons between total and silt accumulation rates with published data, corals near our sites were under stress two to four times as frequently at the developed compared to at the minimally developed locations. Our results demonstrate that sediment traps are an effective way to monitor general spatiotemporal patterns of terrigenous sedimentation and reliable in identifying locations where sedimentation may be inducing stress to corals.

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MARINEGEO (THE MARINE GLOBAL EARTH OBSERVATORY) STUDY: SPONGES AND HABITAT CONNECTIVITY SUPPORT FISH COMMUNITIES IN DEGRADED REEF HABITATS (Abstract ID: 29502)

In 2015 the Smithsonian Tropical Research Institute in Panama (Bocas del Toro, Caribbean Sea) launched a MarineGEO research site (The Marine Global Earth Observatory, http://marinegeo.si.edu), as part of a global monitoring effort across coastal habitats. In the first year the habitat characteristics of the reefs, seagrass and mangrove fringes and the entire fish community (>2.5cm) of the Bocas del Toro region were assessed, also applying methods and tools of other global platforms as Reef Life Surveys (RLS) and CORALNET. Our data set pointed out how severely degraded the reefs, its associated habitats and the fish communities in Bocas del Toro are. The habitat degradation in combination with the ongoing overfishing led to a tremendous loss of fish biodiversity and biomass and a lack of omnivores, high-level carnivores and top predators. What remains is a fish community characterized by juvenile and small size fish, which are able to live in substrates with a low - medium complexity. However, we could also identify some positive drivers for the reef fish community. Sponges, the close proximity of mangroves and the mangrove fish biodiversity increase the reef fish biodiversity and biomass of such degraded systems. Also, they improved the quality of the reef fish community by increasing the trophic level and the overall vulnerability. Negative factors particularly for the reef fish biomass were identified as recently killed corals, zoanthids, rubble and the destruction of the mangrove fringe.

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CORAL TRANSPLANTATION TO MITIGATE DREDGING IMPACTS ON CORAL REEFS FOR A PORT EXTENSION PROJECT (GUADELOUPE, FRENCH WEST INDIES) (Abstract ID: 29600)

The port extension project of Pointe-à-Pitre required the dredging of an access channel, including a coral reef area. Various surveys and mitigation measures were implemented: coral and seagrass transplantations, marine mammal surveys, water quality and noise surveys, sediment extracted quality surveys, and monitoring of marine communities. Other mitigative measures are being considered including the creation of artificial reefs. Public talks were also organized to present the project and its mitigation measures by the Guadeloupe Port Caraibes. Prior to the coral transplantation, several studies were performed to assess the feasibility of the project, determine the health status of the donor coral reefs, identify and characterize the best recipient sites and submit a detailed methodology to authorities for the different phases of the work. In view of all these studies, the State environmental services required a coral transplantation of a minimum of 4 150 coral colonies, taken from two impacted sites (> 3 ha). The transplantation was performed from January to March 2015. Almost 4 200 coral colonies belonging to 22 species and measuring 20 cm to 1.5 m were relocated. Monitoring of both translocated and control corals has begun and will continue over a 3-year period. The recurrent monitoring gauges the success rate of the transplantation, coral growth, signs of bleaching or necrosis, coral recruitment, coral cover, and status of associated fauna. First results indicate an overall success after almost one year post-transplantation.

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THE DNA OF BIODIVERSITY – PREDICTING AND PROTECTING GENETIC DIVERSITY OF REEF COMMUNITIES (Abstract ID: 28937)

As conservation strategies increasingly call for preserving genetic diversity, moving beyond single-species approaches toward community-level trends in genetic diversity is needed. With genetic data for 47 reef species sampled across the Hawaiian Islands, we test a suite of hypotheses about drivers of genetic diversity at the species and community levels. Key species traits mediate response of species' genetic diversity to the seascape. Composite genetic diversity of all sampled species shows an emergent community-level association with metrics of habitat area and species diversity, supporting biogeographic theory and suggesting indicators and strategies for monitoring and preserving genetic resources of coral reef ecosystems. Species substitutions across islands may allow community-level genetic associations with seascape features despite high species-level variance. Correlation of composite genetic diversity to recent thermal stress may signal that genetic resilience of whole reefs is under threat by warming seas. Using highly predictive seascape models of composite genetic metrics across the Main Hawaiian Islands we developed an approach to biodiversity conservation planning that targets seascape features as a proxy for protecting genetic diversity alongside other targets of reef biodiversity conservation. We identify potential areas of high conservation benefit where additional conservation actions could effectively preserve genetic diversity, connectivity, species diversity, coral cover and/or fish biomass of the reef ecosystem.

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FIRST BASELINE SURVEY OF CORAL LESIONS ON VILANGUCHALLI PATCH REEF, GULF OF MANNAR, INDIA (Abstract ID: 29317 | Poster ID: 163)

Incidence and prevalence of coral health issues are increasing globally, yet little work has been done on the coral reefs in India. We conducted the first baseline health study on Vilanguchalli patch reef within the Gulf of Mannar, India. We surveyed 12 transects laid haphazardly on the patch reef. Coral cover was measured via line intercept and all coral lesions observed within belt transects were recorded and photographed. Seven coral genera were found including Montipora, Acropora, Porites, Pocillopora, Turbinaria, Favites and Favia. Average coral cover was 60.0% with acroporids dominant (avg. 46% cover). Several types of lesions were recorded which include bleaching (avg. prevalence 2.0%), sponge overgrowth (avg. prevalence 2.4%), algal abrasion (avg. prevalence 2.5%), and fish and snail predation (avg. prevalence 2.9% and 1.2% respectively). Growth anomalies caused by overgrowth of discarded shells were found in Acropora (4.3%) and Montipora (2.1%). The most common diseases were growth anomalies found in Acropora (avg. prevalence 3.6%) and Porites (avg. prevalence 2.8%). Tissue loss consistent with disease was also found in Acropora with an average prevalence of 1.1%. The reefs in the Gulf of Mannar were severely damaged by coral mining until 2005 when this activity was halted. Reefs continue to be stressed by poor water quality and overfishing. More studies are needed to understand the health and status of these and the other reefs of India.

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LOCALIZED DISPERSAL LEADING TO FAMILY GROUPS IN A WIDESPREAD CARIBBEAN GOBY (Abstract ID: 28209)

Local recruitment has been repeatedly demonstrated by empirical studies investigating the dispersal of coral reef fishes. Local recruitment ranges from rare to common, the extent of which depends on the biology of the species of interest and local oceanographic conditions influencing dispersal. Here we demonstrate an extreme example of local recruitment in a shoaling reef fish *Coryphopterus personatus* (Gobiidae). We found that despite having a larval stage, and a wide distribution across Caribbean coral reefs, *C. personatus* forms groups of highly related individuals at small spatial scales (<10 metres), living alongside full and half siblings as well as cousins. Within 9 reefs in Mesoamerica we found between 2 and 6 family groups per reef. Two mechanisms could explain this pattern: 1) larval coherence in the pelagic environment can lead to siblings from the same larval cohort living on the same reef as adults; 2) low levels of dispersal or lack of dispersal. We found that highly related individuals spanned multiple cohorts of individuals and we could not rule out the possibility of offspring and parents living on the same reef. This suggests that dispersal in the species may be highly reduced, similar to recent findings from other reef dwelling gobies.

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ASSESSING TRENDS IN TARGETED MARINE FISHES IN THE BONAIRE MARINE PARK, LEEWARD ANTILLES CARIBBEAN (Abstract ID: 30074)

The Bonaire Marine Park (BMP), established in 1979 and encompassing the islands of Bonaire and Kline Bonaire, represents one of the oldest marine parks in the Caribbean. Primary human uses of the park include recreational diving and snorkeling, and subsistence fishing by local people. The BNP is comprised of a network of protected areas with differing human-use restrictions; no area in the park is currently restricted from

subsistence fishing. One of the primary goals of the park is to maintain a regionally and globally significant and successful multi-use marine protected area. It remains unclear, however, to what extent high-quality opportunities for extractive and non-extractive uses are being maintained through time. Since 1993, volunteers with Reef Environmental Education Foundation (REEF) have conducted reef fish surveys (species-specific presence/absence and relative abundance) at sites throughout the park. To date, over 21,000 surveys have been conducted, representing ~28,000 hours of collective survey effort. Using these data, we examined trends in the presence and abundance of marine fishes targeted by subsistence fishing (e.g. grouper and snapper) over the last two decades. We found an ongoing decline in many targeted species, suggesting that extractive uses are decreasing the quality of non-extractive uses such as wildlife viewing over time. Given the importance of vibrant and healthy reefs to locals and tourists alike, we suggest that BMP managers take action to reverse trends in fish populations.

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ACROPORA PALMATA'S LAST STAND IN THE FLORIDA KEYS? (Abstract ID: 29728)

The decline of acroporid corals throughout the Caribbean over the last 30 years has been well-documented, with noted mortality of this primary reef-builder most evident along the Florida Reef Tract. While the framework of bank reefs created by Acropora palmata remains, the spatial extent of the population itself has dwindled so substantially that only few areas of multiple extant colonies remain across the reef tract as a whole. Data from recent monitoring at 10 sites in the Florida Keys reflect particularly alarming losses, including localized extirpation at a few sites within the Lower Keys. These losses are not equally distributed across sites, and while chronic drivers of decline (predation and disease) occurred at all sites, their relative impact is neither geographically nor temporally uniform. Recent severe bleaching events of 2014 and 2015 affected sites differently as well, notably causing near complete mortality at sites chronically impacted by coral-livorous snails as well as sites previously showing high growth and low mortality (although low genotypic diversity). The prevalence of corallivorous snail predation increased on the remaining colonies and continued to cause high mortality on the remaining tissue. Ultimately, chronically stressed corals seemed to be more susceptible to bleaching events, but even sites documented as healthy can suffer mass mortality. With an extensive El Nino event expected to continue in 2016, Florida's Acropora palmata population may become increasingly restricted to even fewer sites. Minimizing local stressors may provide some relief for A. palmata, but it will not remove the bleaching threat.

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GOT BIOMARKERS? TRANSCRIPTOMICS TO RESCUE CORAL HEALTH (Abstract ID: 29629)

Water quality is both a critical component of coral health and relevant to reef management at the local scale. Following 2002-06 guidelines by the US Coral Reef Task Force, local stakeholders developed strategies to reduce land-based pollution (LBP) by 25% in priority U.S. watersheds. However, basic biological information regarding the suitability and efficacy of the proposed reductions to alleviate threats to corals is still lacking. Determining LBP response thresholds and threat reduction levels for corals is essential to effective management and conservation, including the development of best land management practices (BMPs) to promote the recovery and persistence of reef-building corals. In this study, we use RNASeq to identify key genes in the stress response of four Hawaiian corals exposed to sediment stress in the laboratory. Gene expression responses correlated to the severity of sediment exposures indicated the best biomarker candidates. Antibodies designed to target the proteins encoded by those genes were then used with Western blots and ELISA to validate the candidate biomarkers on samples from controlled sediment exposure experiments. We subsequently calculated the change in biomarker expression to evaluate the health of corals experiencing sediment stress in the field. These new biomarker tools provide reef managers and stakeholders with sensitive and accurate pre-bleaching diagnostics of the coral stress response so that BMPs can be tailored to effectively support reef sustainability.
http://www.foseneca.com

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FIRST CORAL DISEASE ASSESSMENT IN THE LAST MARINE SANCTUARIES IN THE SOUTH WESTERN INDIAN OCEAN: EPARSES ISLANDS (Abstract ID: 29352)

Coral diseases have caused a worldwide decline in the biodiversity and abundance of reef-building corals. These diseases are known to generate progressive tissue loss and affect coral growth, reproduction, recruitment, species diversity and the abundance of reef-associated organisms. While studies of coral disease have increased, no attempts have been made to identify infectious diseases on the French Eparses Islands. This study provides baseline data on coral disease prevalence on Glorieuses, which is one of the most pristine ecosystems, preserved from anthropogenic impacts due to its geographical isolation and a historically very limited human occupation. Surveys were conducted in December 2015 at seven latitudinal sites and across two reefs (reef slope and reef flat) and revealed the presence six disease conditions including Acropora white syndrome (AcrWS), Acropora BBD (AcrBBD), Porites white patch syndromes (PWPS), Pocillopora white syndrome (PocWS) and Seriatopora WS (SerWS). Unexpectedly, we recorded high levels of diseases with the highest disease prevalence seen at the sites closest to Ile du lyse which is a breeding ground for large number of seabirds. The data suggest that seabird's populations may have an impact on the susceptibility of corals to disease. Results of this study offer a baseline dataset of disease in these unique natural laboratory and indicate the need for continued monitoring.

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DIVE INDUSTRY'S CHALLENGES AND OPPORTUNITIES TO COPE WITH CORAL BLEACHING IN INDONESIA. A RAPID ANALYSIS ON DIVER PERCEPTION IN BUNAKEN, BALI, AND GILI. (Abstract ID: 28650 | Poster ID: 671)

The mass coral bleaching event of 2009-2010 was documented in Indonesia, where up to 100% bleaching was recorded in shallow waters. To investigate potential impacts of mass bleaching events to dive operators, a diver perception survey elicited the expectations and experiences of 192 divers in Bunaken, Bali and Gili Matra in 2010. Results show that most divers were aware of the phenomenon of coral bleaching, and the diving experience was an important reason for their destination choice. Interestingly, less than half of the divers indicated they would have changed their holiday destination, and <25% would have changed their holiday activity, had they known, prior to booking the dive, that the coral was bleaching. In general, across all sites, divers valued dive conditions and dive operation experience over marine life and perceived reef condition. Aspects that made them most happy were customer service and friendliness. Furthermore, divers across the sites consistently preferred dive operators that actively support reef management. The divers were also willing to implement reef protection measures during bleaching for example, through site closures. This research shows that dive industries can cope with bleaching events if the service is high quality and the physical environment remains in good condition. The challenge will be to ensure that bleaching doesn't deteriorate the reef to the point that it significantly reduces divers' willingness to dive in a site.

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LARGE-SCALE MOVEMENT AND HABITAT RANGE OF REEF MANTA (*MANTA ALFREDI*) IN NORTHERN RAJA AMPAT WATERS, WEST PAPUA, INDONESIA (Abstract ID: 28485)

Little is known about the habitat range and movement patterns of reef mantas in Raja Ampat, Indonesia. This study aimed for investigating the behavioural movement patterns and habitat range of reef mantas to underpin the conservation efforts and management actions of this species in Raja Ampat region. The mantas were tagged with Vemco V16 acoustic transmitters. In November 2013, Vemco VR2W acoustic receivers were deployed in eight listening stations throughout northern Raja Ampat waters, including Wayag Lagoon, Uranie, Eagle Rock, Yefnabi Kecil, Seprang, Dayan, Manta Ridge, and Wai. A total of 38 reef mantas were tagged in six locations. Tagging periods in general varied between 0 to 682 days (237±27 days). Moreover, the total number of days of visits ranged from 1 to 188 days (42±7 days). Manta Ridge was the most popular site with 565 days of cumulative number of days of visits. It was followed by Yefnabi Kecil (434 days), Eagle Rock (287 days), and Wai (202 days). In addition, several mantas were detected in five listening stations and most of them travelled to at least one listening sta-

tion. Interestingly, results indicate that manta seasonal movements occurred within four main listening stations (Manta Ridge, Wai, Yefnabi Kecil, and Eagle Rock). Furthermore, nearly 90% of manta visitations in all listening stations occurred during the day between 06:00 am to 06:00 pm. Overall, those results can be used to assist in the designation of manta conservation strategies, both spatially and temporally to ensure manta populations and manta tourism sustainability in Raja Ampat.

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THE EXPRESSION OF DIFFERENT CELLULAR-STRESS BIOMARKERS TO ASSESS THE RESPONSE OF CORALS TO DISEASES (Abstract ID: 28350)

Coral diseases are increasing in both the occurrence and incidence, threatening the health of coral reefs worldwide. To date, although many diseases are ecologically well documented and efforts have been performed in the identification of the microbial communities associated, less attention has been given to the effects of the pathogen presence on coral health/physiology and about the mechanisms employed by corals to fight and resist to infection. For this reason the expression of some cellular stress biomarkers for detecting early signs of change in a coral's physiological state were analyzed in corals affected by diseases, at different distances along the advancing front of the infection. In particular, the modulation of the mitochondrial heat shock protein 60-kDa (Hsp60) was investigated in Acropora muricata colonies infected by the ciliate-related diseases Skeleton Eroding Band and Brown Band in the lagoon of Maghodhoo Island, Faafu Atoll, Maldives. At the same time, the expression profiles of Hsps, oxidative stress-inducible proteins and antioxidant enzymes, such as superoxide dismutase, were compared during the progression of the Black Band disease in colonies of Goniopora cf. columna. The results provide new insights into the immune response of corals. Furthermore, they highlight as different pathogens trigger different cellular responses and defense mechanisms in corals, suggesting as the analysis of the expression of these cellular-stress markers could be a useful tool for examining physiological variations that are not detected at the morphological level.

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NUTRIENT EFFECTS ON GROWTH AND BIOMASS OF DOMINANT REEF CONSTITUENTS (Abstract ID: 29215 | Poster ID: 239)

Degradation of coral reefs has been accelerating at an alarming rate worldwide. Introduction of nitrates and phosphates stimulates algal growth allowing them to outcompete calcifying organisms such as corals in eutrophic environments. Additionally, there is evidence to suggest nutrient availability can inhibit calcification and promote bioerosion even in the absence of algal competition, further shifting the reef community towards net erosion. The complexity of assessing the effects of nutrients on coral reefs is further exacerbated by the diversity of the benthic community. While much information is available on primary production, calcification, and dissolution on reefs at a variety of nutrient conditions, the individual responses of the reef inhabitants are not widely available for multiple reef constituents. In this study, we examined the biological responses of dominant coral reef components of Kāne'ohe Bay under increased nutrient availability. Three replicates of four coral reef substrates, coral (Montipora capitata and Porites compressa), macroalgae (Gracilaria salicornia), coral rubble (naturally conditioned Porites skeletons), and sediment were exposed to three nutrient levels in a press experiment for a period of six weeks. We calculated growth rates using changes in buoyant weight (coral, coral rubble), wet weight (algae), and % organic content (sediment) to determine the biological response of each substrate to nutrient addition. Our results will provide the capacity to parse reef response to individual constituents and compare this to reef assemblage response.

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TRANSFORMATIVE AGENDAS REQUIRE TRANSFORMED INSTITUTIONS: LESSONS LEARNED IN CAPACITY BUILDING FOR OCEANS GOVERNANCE (Abstract ID: 28697)

Long-term ocean and coastal sustainability depends upon good governance implemented on-the-ground and in-the-water, as is reflected in the new U.N. Sustainable Development Goals pertaining to oceans and coasts. Transformative agendas, like the SDGs for oceans and coasts, require transformed institutions. Thus, many are calling for capacity building and science and technology transfer to assist the world's governance institutions to implement. This reflects a broader call of late for capacity building – in marine protected areas, in fisheries management, in enforcement, in national ocean policies. But as broadly as capacity building is called for, very little guidance exists in peer reviewed or other literature, on capacity building for ocean and coastal management. What do we mean by capacity building? What works, what doesn't, and why? This paper will present results from learning exchanges and expert elicitation among those who have delivered and those who have received capacity building for ocean governance in Asia, the Pacific Islands, the Caribbean, and the Mediterranean. It will explore basic approaches, advancements, challenges and solutions – and recommendations for best practices by these experts.

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SPATIOTEMPORAL VARIABILITY IN NET COMMUNITY CALCIFICATION OF A WESTERN PACIFIC CORAL REEF SYSTEM (Abstract ID: 29053)

Measurements of Net Community Calcification (NCC) are increasingly used to establish baseline calcification rates of modern reef systems and to project coral reef futures under 21st century ocean acidification (OA). We measured NCC of two coral reef communities in Palau in the western Pacific, one an exposed barrier reef on the northwest side of the archipelago, and the other a semi-enclosed lagoon within Palau's low pH Rock Islands. NCC rates at both locations were determined for two different years using carbonate chemistry, hydrodynamic, temperature, and salinity data collected over the full diel cycle for multiple four day deployments. Communities on both reefs maintained positive net calcification during all deployments. However, we observed spatial and temporal variability in NCC that cannot be explained by changes in reef source water pH. In 2013, lagoon and barrier reef NCC rates were comparable despite a large discrepancy in source water pH (ave barrier = 8.05 ± 0.01; ave lagoon = 7.94 ± 0.01). Yet within the lagoon, NCC rates in 2012 (17.0 – 23.7 mmol m-2 d-1) were half those in 2013 (42.0 – 48.1 mmol m-2 d-1), with little change in source water chemistry. Similarly, barrier reef NCC rates halved between 1994 and 2000, despite a relatively small change in ocean pH. NCC declines at both locations correspond with coral bleaching caused by high water temperatures linked to ENSO. Our results suggest that the impact of temperature on calcification is critically important in modulating NCC and must be taken into account when projecting coral reef futures under OA.

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FISH-DERIVED NUTRIENT HOTSPOTS SHAPE CORAL REEF BENTHIC COMMUNITIES (Abstract ID: 29583)

Animal-derived nutrients play a strong role in structuring nutrient regimes within and between ecosystems. When animals undergo repetitive, aggregating behavior, they can create nutrient hotspots where rates of biogeochemical activity are higher than in the surrounding environment. We examined the potential for reef fishes from the family Haemulidae to create nutrient hotspots and the potential impact of these hotspots on reef communities. We tracked the schooling locations of diurnally migrating grunts, and their impact on benthic communities. Grunt schools showed a high degree of site fidelity, repeatedly sheltering at the same coral heads and these aggregations created nutrient hotspots around coral heads where nitrogen and phosphorus delivery was roughly 10 and 7 times respectively greater than at structurally similar sites lacking schools of these fishes. In turn, herbivore grazing rates at grunt-derived hotspots were over 3x those of non-shelter sites, and coral growth roughly 1.5x greater. This led to distinct benthic communities with more crustose coralline algae and less upright fleshy algae. Our results suggest schooling reef fish are important in mediating coral reef community structure and that overfishing may impair the development of healthy reef communities. As such, management strategies should consider protecting mesopredatory fishes in addition to

herbivores and top-tier predators. Furthermore, restoration strategies may benefit from providing structure for schooling fishes or focusing coral out-planting around existing nutrient hotspots.

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MARINE BIODIVERSITY AT TAIPING ISLAND AND PROPOSAL FOR ESTABLISHING MARINE PROTECTED AREA AT THE SPRATLY ISLANDS (Abstract ID: 28557)

Taiping Island, controlled by the Taiwan government, is the largest island of Spratly in SCS. The Spratly islands are a myriad of coral reefs which support abundant biodiversity and fishery resources. Based on a 2-4 day survey in 2014 at Taiping Island, a total number of 232 species of terrestrial plants and animlas, 796 marine species were recorded. A book and a DVD entitled "A Frontier in the South China Sea " were published to document Taiping Island's rich biodiversity both on land and underwater. The result from a feasibility study in 2009 proposed to establish Taiping Island as a Marine protected area (MPA) or a Marine Peace Park (MPP). However, the authority has yet to approve either one. Due to its importance in economy and national defense, the area is the subject of overlapping territorial claims by surrounding countries. Recent large-scale dredging and filling operations will be detrimental to the marine biodiversity and fishery resource in SCS. "The South China Sea Peace Initiative," announced by President Ma of Taiwan, called on all claimants to temporarily shelve their disagreements to enable negotiations on sharing resources. But the authority only focused on making Taiping Island a low-carbon base for humanitarian aid at the moment. We hope their next step will be to establish the Island as a MPA or MPP and to prioritize conservation as the priority. Here we suggest that each disputed country should establish local marine protected areas at the sites currently under their control, and to encourage international academic collaboration among the sites. These efforts can ensure the conservation and sustainable use of all resources within the Spratly Islands.

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CORAL ON A CHIP: A MICROFLUIDIC PLATFORM FOR STUDYING REEF-BUILDING CORALS AT THE MICROSCALE (Abstract ID: 27891)

Coral reefs, which form the basis to some of the most productive ecosystems on earth, are currently facing major challenges due to rapid changes to their natural habitat driven by human activities and climate change. Understanding these challenges is hampered by the lack of a robust experimental approach for studying the microscale processes governing corals' interaction with their environment and with the multitude of microorganisms living in, on and around them. To meet this challenge we developed the Coral on a Chip, a novel experimental platform that combines micropropagation and microfluidic techniques to allow microscopic observation of live coral polyps. The small size and transparency of coral micropropagates make them ideally suited for live-imaging microscopy, while the microfluidic platform facilitates long-term visualization under controlled environmental conditions. The use of micropropagation enables us to produce of a large number of clonal polyps from a small coral fragment, reducing sample variability and simplifying experimental design. We demonstrate the application of this platform by imaging coral micropropagtes at previously unattainable spatio-temporal resolutions, providing new insights into several microscale processes including coral calcification, coral-pathogen interaction and the loss of algal symbionts ('coral bleaching'). The Coral on a Chip thus provides a new and exciting method for studying coral physiological processes in-vivo at the single cell level, opening new vistas in coral biology.

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INVESTIGATING THE INFLUENCE OF SYMBIODINIUM PSYGMOPHILUM DENSITY ON PROKARYOTIC COMMUNITIES IN THE CORAL ASTRANGIA POCULATA (Abstract ID: 29653)

The facultatively symbiotic coral Astrangia poculata naturally exhibits a wide range in Symbiodinium psygmophilum densities and can be used to explore the role of Symbiodinium in structuring the coral microbiome. Wild A. poculata colonies occur in two symbiotic states, "brown" and "white," based on Symbiodinium cell quantification. 16S rRNA gene amplicon sequencing suggests that microbiome composition in brown and white colonies is similar to that in tropical corals. While bulk diversity and taxonomic composition are generally similar between brown and white colonies, several key microbial taxa are differentially enriched. Endozoicomonas bacteria, detected in diverse tropical hard and soft corals, are enriched (10-fold) in brown colonies. Sulfate-reducing bacteria (Desulfobacteraceae) are also enriched in browns. In contrast, sequences from ammonia oxidizers (Thaumarchaeota) and nitrite oxidizers (Nitrospina/Nitrospira) are enriched in white colonies, suggesting a role for Symbiodinium in structuring nitrogen cycling in Astrangia. Metagenomic data from Astrangia microbiomes are being analyzed to confirm functional differences in carbon, nitrogen and sulfur cycling potential between white and brown colonies. Based on these results, we propose a conceptual model describing how S. psygmophilum alters local substrate availabilities within the host colony and exerts influence on the associated prokaryotic communities. These results can be framed within the larger context of how Symbiodinium affects the bulk functions and overall stability of the multi-partner coral holobiont.

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EFFECTS OF ST. LUCIE ESTUARINE DISCHARGE WATER AND THERMAL STRESS ON *MONTASTRAEA CAVERNOSA* (Abstract ID: 28850 | Poster ID: 409)

Coral reef declines, particularly in coastal zones, have been linked to temperature stress and anthropogenic impacts on water quality. St. Lucie Reef near Stuart, Florida, USA receives increased estuarine efflux as a result of watershed changes and management policies that have substantially altered historic natural flows. This research examines the direct effects of estuarine discharge water and thermal stress on corals, and supplements existing *in-situ* monitoring on St. Lucie Reef with *ex-situ* factorial experimental design. Ambient and elevated temperatures (25°C and 30°C) and offshore water versus estuary discharge water collected from the St. Lucie Inlet were used to investigate the individual and interactive effects on*Montastraea cavernosa*, one of two dominant scleractinian species at St. Lucie Reef. Coral stress gene expression, zooxanthellae density, and chlorophyll concentration were evaluated to determine effects on the corals and their symbionts. Collaborative partnerships with the Florida Fish and Wildlife Commission, Florida Department of Environmental Protection, and the St. Lucie Inlet Preserve State Park facilitate data sharing to inform decision making for South Florida's resource management strategies. Creating effective resource management is crucial for the conservation of coastal ecosystems impacted by land-based sources of pollution both locally and globally.

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THE EVOLUTION OF MARINE LARVAL DISPERSAL KERNELS IN SPATIALLY STRUCTURED HABITATS (Abstract ID: 28317)

Understanding the patterns, causes and consequences of marine larval dispersal is a major goal of marine ecology. Most research on the causes of variation in dispersal focuses on proximate causes, e.g., physical oceanography and larval behavior. Here, we investigate the ultimate, evolutionary causes of variation in dispersal. Building on Hamilton and May's (1977) classic paper "Dispersal in stable habitats", we develop a set of simple models for the evolution of larval dispersal kernels in spatially structured habitats. First, we extend Hamilton & May to understand how parents will allocate to different dispersal distance classes in a world without bound. This creates a paradox: parents allocate most to the longest dispersal distance class. Second, we investigate dispersal distance allocation in a world with bound. This resolves the first paradox, but creates its own paradox: parents allocate next to nothing beyond the shortest dispersal distance class. Third, we investigate dispersal distance allocation in a world with bound and patchiness. This produces a more realistic result: parents allocate more to longer distance classes. Finally, we investigate the evolution of the kernel in a real seascape and test the predictions of our model against an empirically derived kernel from that seascape. There is a good fit between the model's predictions and empirical data. This study provides a framework that can be used to model the evolution of dispersal kernels in other species and seascapes, which will provide new insights into variation in patterns of population connectivity.
http://people.bu.edu/buston/lab/Welcome.html

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EFFECTS OF CARBONATE CHEMISTRY ON METABOLISM OF AN EXPERIMENTAL CORAL REEF COMMUNITY (Abstract ID: 28568)

In situ studies have shown net community calcification (Gnet) to be correlated with pCO2 levels that vary naturally in space or time. However these relationships can be confounded by covariation between carbonate chemistry and other environmental parameters. Here we created experimental reef communities in flumes and exposed them to a range of pCO2 levels over multiple months. Seawater pCO2 treatments reflected those predicted under atmospheric CO2 levels of 400 (ambient), 700, 1000 and 1300 µatm. Under ambient conditions, communities had Gnet of ~90 mmol m-2 d-1, within the range

of values observed for in situ reefs. Gnet was significantly related to pCO2 and declined by 23% of the ambient rate per unit decline in aragonite saturation state. Net community production was not significantly related to carbonate chemistry. The change in Gnet from ambient to treatment was consistent over time (from days to months of exposure) for the 700 µatm treatment, but for the 1000 and 1300 µatm treatments, Gnet was lower after months of exposure, compared with the response after several days. Our results also showed short-term variability in Gnet of the ambient pCO2 (400 µatm) treatment. These results have important implications for selecting the duration of pCO2 exposure in both experimental and in situ studies that rely on temporal variation in carbonate chemistry. They also highlight the importance of long-term in situ community metabolic measurements for accurate comparisons between sites, and for detection of future change.

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LOCAL BLEACHING THRESHOLDS ESTABLISHED BY REMOTE SENSING TECHNIQUES VARY AMONG REEFS WITH DEVIATING BLEACHING PATTERNS (Abstract ID: 27889)

In August / September, 2012, a severe bleaching event affected coral communities off the coast of Abu Dhabi in the Arabian Gulf. In Saadiyat and Ras Ghanada reefs ~40% of the corals showed signs of bleaching. On contrast, only 15% of the corals were affected in Delma Reef. Bleaching threshold temperatures for these sites were established using remotely sensed sea surface temperature (SST) data recorded by MODIS-Aqua. The threshold temperatures varied between locations, resulting in site-specific deviations in the numbers of days during which these thresholds were exceeded. Hence, the less severe bleaching of Delma reef can be explained by the lower relative heat stress experienced by this coral community.
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CRYPTIC DIVERSITY UNPREDICTABLY AFFECTS MEASUREMENTS OF POPULATION DIFFERENTIATION IN CORALS (Abstract ID: 28246)

Cryptic diversity is commonly detected across diverse taxa with interspecies differences having the potential to significantly inflate or deflate population genetic correlates of dispersal capabilities. The widespread Pacific corals Acropora cytherea and hyacinthus together contain eight often sympatric cryptic species. Using 199 single nucleotide polymorphisms, we assessed population differentiation of these eight species across three geographic scales (between archipelagos, between reefs within archipelagos, and within reefs) and tested how unaccounted cryptic diversity may affect these estimates. At large geographic distances (>700 km), comparisons among the eight largest archipelagos always displayed significant genetic differentiation for all species. At moderate distances (2-100 km), significant genetic differentiation was detected in 10 out of 17 between reef comparisons in populations of the five most abundant species. Genetic structure was not found at the smallest scale (10s m) when examining two species within two reef sites. When A. hyacinthus species were merged as if cryptic identity was unknown, population differentiation estimates between archipelagos and reefs greatly increased or decreased depending largely on the mix of cryptic species between locations, leading to inaccurate conclusions on genetic structure. Recognizing cryptic diversity is fundamental to accurate estimates of connectivity.

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COMPARING IN SITU AND SATELLITE-BASED WATER TEMPERATURE DATA OVER TROPICAL CORAL REEFS: IMPLICATIONS FOR ENVIRONMENTAL MONITORING AND ECOLOGICAL FORECASTING (Abstract ID: 29432 | Poster ID: 550)

Thermally-driven coral bleaching contributes significantly to the global decline of coral reefs on which many coastal populations and economies depend, and bleaching models can provide valuable guidance to reef managers for monitoring, mitigation, and recovery activities. These tools frequently use daily 5-50 km satellite estimates of sea surface temperature (SST) over open water as proxy for subsurface conditions in the reef zone. However, land-adjacency effects and the influence of local-scale (< 5 km) environmental conditions introduce uncertainty to satellite-based estimates of water temperatures in near-shore, shallow (< 30 m) reef zones. Particularly, localized oceanographic influences (e.g., upwelling, diurnal heating, micro-currents) that are not resolved by the satellite data may affect bleaching susceptibility and introduce error into ecological forecasts. To investigate these concerns, a series of water temperature profiles were deployed on coral reefs around Little Cayman Island to simultaneously collect surface and subsurface temperature data. Data from these profiles are analyzed to identify local-scale behaviors and are compared to 5-km satellite estimates of SST to quantify bias. We evaluate the differences between the data sources, quantify the scope of local-scale variability, and discuss steps toward data integration that can better inform ecological forecasting models for coral bleaching and recovery.

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BUILDING ISLAND RESILIENCE AGAINST CLIMATE CHANGE THROUGH A COMMUNITY-BASED WATERSHED AND CORAL REEF REVIVAL INITIATIVE (Abstract ID: 29934 | Poster ID: 682)

Climate change is a clear and present threat in small tropical islands, requiring solutions at both global and local levels. This study took a community-based approach to building island resilience against climate change. The removal of local environmental stressors restores natural ecosystem functions, promoting resistance to and more rapid recovery from global climate change impacts. The Humåtak Project (humatakproject.org) was developed in Guam as a community-based initiative directed at reducing accelerated erosion, a major local environmental stressor caused by poor land-use practices. Erosion results in sedimentation on coral reefs, which smothers and kills corals, interferes with coral reproduction and recruitment, and destroys essential fish habitat. A six-part community engagement strategy was deployed and partnerships were formed with a village mayor, local and Federal government agencies, and academia. Nearly 2,000 volunteer hours were contributed to reducing erosion in the La Sa Fu'a Watershed. Tree seedlings and sediment filter socks were tested as watershed restoration tools over a 21-month period. These tools were effective in trapping 112 metric tons of sediment on land. Based on the efficiency of these tools, management recommendations were developed to bring Fouha Bay below severe-moderate sedimentation stress (>50 mg $cm^{-2}day^{-1}$). The community engagement strategy and data generated on the effectiveness of watershed restoration tools can be used in management plans to build resilience against climate change in other tropical islands.

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RAYS ON REEFS: PRELIMINARY RESULTS FROM THE GLOBAL FINPRINT PROJECT IN SOUTH EAST ASIA (Abstract ID: 29138 | Poster ID: 276)

Fishing pressure on ray populations in South East Asia is high. They are caught for their meat and their skin. Currently, there is little understanding of ray diversity and abundance in coral reef ecosystems in this region limiting conservation action. The Global FinPrint Project is the first global survey of elasmobranchs in coral reef ecosystems and is sampling intensively in South East Asia. The project uses baited remote underwater video systems (BRUVS) to determine relative diversity and abundance. This PhD project is using the Global FinPrint data from South East Asia to better understand the ecology of rays in coral reef habitats. Preliminary analyses from selected South East Asia locations will be presented. Data collected will be used to inform management of ray populations by identifying areas of low diversity and abundance. It will also be used as a baseline for future studies.
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DESIGNING INTERVENTIONS TO IMPROVE MARINE AREA MANAGEMENT (Abstract ID: 29638 | Poster ID: 624)

Lack of effective management of marine managed areas (MMAs) has resulted in a continuous decline in the condition of nearshore and coastal areas in the Eastern Caribbean. This issue is exacerbated by threats such as overfishing, unsustainable coastal development and climate change. Furthermore, protected area managers are concerned that MMAS are not achieving the objectives for which they were established. Under the Eastern Caribbean Marine Managed Areas Network (ECMMAN) project, the Management Effectiveness Tracking Tool (METT) was used to set a baseline for current

management status of 7 MMAs across 6 countries. The overarching ECMMAN project goal is to establish an ecologically representative, socio-economically beneficial, climate resilient, and effectively managed MMA network. Since METT is a simple and rapid site assessment system for tracking progress of management actions over time across related areas, it provided an effective assessment tool for comparisons across the ECMMAN network. Management strengthening programs were designed for all 7 MMAs and have begun implementation since 2014. METT has continually been used to monitor progress towards improving management effectiveness at these sites. There have been noticeable improvements in the overall management of these 7 sites in key areas such as implementation of management objectives; enforcement of regulations; biophysical, socio-cultural and economic research and monitoring; stakeholder awareness, concern and participation; and successes towards threat abatement.

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PAST WATER ENVIRONMENT OF KABIRA BAY RECORDED BY ISOTOPES AND TRACE ELEMENTS OF CORAL SKELETON (Abstract ID: 29217 | Poster ID: 232)

Kabira bay, which locates in Ishigaki Island, Okinawa, Japan is known as one of the most beautiful coral reef in Okinawa. In recent years, local people feel that turbidity in Kabira bay is getting higher because of some environmental pollutions such as a runoff of red clay, a culture of pearl oyster and a tourism of glass boat. It is important to investigate the past water environment in the Kabira bay to distinguish recent turbidity level from the past and identify the source of the pollution and the initiation time for a future management of the bay. In this study, we analyzed the isotopes of $\delta^{18}O$ and $\delta^{13}C$ and some trace metals in coral skeleton, and reconstructed the water environment in Kabira bay past 50 years. Oxygen isotope ratio decreases in summer and increases in winter. Temperature dependence was -0.125 ‰/°C in the mouth of the bay, -0.173‰/°C in the center, -0.106 ‰/°C in the closed-off section of the bay. A result of these values is close to those reported in the literatures (e.g. Tsunoda et al., 2006). Carbon isotope ratio showed a significant decrease since 2000 at samples taken from a closed-off section of the bay. This result indicates the possible effect of some pollutants to deteriorate a light environment for coral photosynthesis. Trace metals, such as Mn, Al and Sn, increased from 1976 after the reversion of Okinawa to Japan, indicating the rapid developments on land around Kabira bay.

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EGG FORMATION OF A STONY CORAL, *EUPHYLLIA ANCORA* (CNIDARIA, ANTHOZOA): A MOLECULAR PERSPECTIVE. (Abstract ID: 28130)

Sexual reproduction of stony corals has been studied in many species worldwide. Although various aspects of sexual reproduction, such as spawning, sexuality, and gametogenesis, were extensively investigated during the past three decades, the intrinsic mechanisms of sexual reproduction remain almost unknown. To gain a better understanding of coral gametogenesis at both the molecular and cellular levels, as a first step, we focused on the oogenesis of a stony coral *Euphyllia ancora*, and investigated 1) what kind of molecules are mainly accumulated in the coral eggs, and 2) how these molecules are formed in the coral body during the oogenesis. We found that the coral possesses at least 3 types of yolk proteins, namely, Vitellogenin (Vg), Egg protein (Ep), and Euphy. Analysis of tissue distribution by quantitative RT-PCR demonstrated that these yolk proteins were highly expressed in the ovarian tissues. Subsequent mRNA *in situ*hybridization demonstrated that mRNA of these 3 yolk proteins were present in ovarian somatic cells adjacent to oocytes. Immunohistochemical analyses with anti-Vg, Ep, or Euphy antibodies showed the immunoreactivities of these 3 yolk proteins in both oocytes and ovarian somatic cells. These results demonstrated that the ovarian somatic cells, but not the oocytes themselves, synthesize these 3 yolk proteins in the ovarian tissues. Thus, yolk proteins produced in the ovarian somatic cells would be transported to the oocytes. Our data provide new information that contribute to a more comprehensive understanding of coral egg formation.

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ARE SUCCESSFUL REEF FISH SIMPLY BORN 'LUCKY' OR DO THEY 'PLAY THEIR CARDS WELL'? (Abstract ID: 28027)

Biology is the story of winners and losers; winners survive better, produce more offspring, and thus differentially contribute to population growth. Like any game, timing is paramount -- winners may be born at the right time. Indeed, in the face of uncertainty, parents can spread out reproductive timing, but this bet-hedging will stack the deck in favor of some offspring. Are fates set by parents, or can offspring improve upon the cards they've been dealt? Our work investigates the roles of parental investment, birth timing, and developmental progression as determinants of fitness components. We focus on the sixbar wrasse (*Thalassoma hardwicke*), a species of reef fish that spawns frequently to produce offspring that navigate a series of demographic bottlenecks with fitness consequences. We sampled settlement and survival of fish on 192 patch reefs over six months, and documented lunar periodicity in settlement (greatest during new moons) and survival (greatest for fish that settled during- or just prior to new moons). Fish also varied in their size-at-settlement, suggesting that some individuals may accelerate or delay development to target good 'settlement windows'. We evaluate the 'decisions' of settling fish in the context of density dependence, priority effects, and environmental heterogeneity, and propose an eco-evolutionary hypothesis that could account for the evolution of iteroparous life-history strategies.
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THE THERMAL TOLERANCE OF CORAL-ASSOCIATED BACTERIAL COMMUNITIES ACCLIMATED TO TEMPERATURE STRESS BASED ON SEASONAL THERMAL HISTORY (Abstract ID: 28052)

Corals and their microbial symbionts could resist thermal stresses and acclimated to thermal fluctuations. However, the effects of temperature fluctuation and seasonal acclimation on coral-associated bacteria remain unclear. To investigate this question, we conducted coral incubation experiments with different temperature treatments. Coral samples were collected at Penghu Islands in Taiwan. Seawater temperature of the sampling site ranged from 12.1 to 23.1 °C in winter and 23.4 to 30.2 °C in summer. The experiment comprised six temperature treatments (i.e., from 10 to 33°C) for nubbins from the coral *Acropora muricata* in summer and winter, respectively. Moreover, the changes in coral-associated bacteria were detected at three time points for each tank. The partial 16S rRNA sequences were used to identify composition of bacterial communities using Illumina sequencing. Bacterial communities between seasons were different in compositions and dominant species. For different temperature treatments, the dominant bacteria were gradually altered during incubations. Interestingly, such the shifting occurred in the corals collected in winter required longer and lower temperature treatments than in summer. Besides, the change in *Endozoicomonas* , health-associated bacteria, showed a similar shifting pattern. In short, changes in coral-associated bacteria presented a new evidence to suggest that seasonal acclimation may increase the coral resistance to thermal fluctuation.

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MODELING THE IMPACTS OF SEA-LEVEL RISE AND CHANGING WAVE CONDITIONS ON ATOLL ISLANDS: INSIGHT FROM WAKE AND MIDWAY ATOLLS, NORTHWESTERN HAWAIIAN ISLANDS (Abstract ID: 29706 | Poster ID: 403)

Low-lying atoll islands are dynamic landforms experiencing changing erosion and accretion patterns due to changes in waves and sea level. These changes can threaten infrastructure and island communities via increased run-up, flooding, and loss of inhabitable area. To enable managers to implement effective mitigation and resiliency efforts, it is critical to understand how climate change will drive alongshore variations in flooding and erosion/accretion patterns. A Delft 3D model and empirical formulations were used to investigate potential climate change effects at two atolls in the Northwestern Hawaiian Islands, Wake and Midway. Using winter and summer end-member wave conditions, different scenarios were modeled by varying sea level at intervals between 0.0 to +2.0 m, incident wave heights from –0.3 to +0.3 m, and incident wave directions from –15.0° to +15.0° relative to current conditions. The results indicate that the greatest magnitude changes are along ocean-facing shorelines, primarily where the reef flat is narrowest. However, the portions most vulnerable to sea-level rise and changing wave conditions are the alongshore (longitudinal) ends of islands and the lagoon-facing shorelines, with each displaying the greatest proportional change in erosion and wave-driven run-up, and large heterogeneity between atolls. Together, these results suggest that the ends of atoll islands and lagoon shorelines will be most impacted by projected climate change and management decisions should take these potential changes into account when planning future investments.
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SOURCES OF VIBRIO CORALLIILYTICUS STRAIN OCN008 IN KANEOHE BAY, HAWAII AND THE EFFECT OF DECREASED SALINITY ON INFECTION OF THE CORAL, MONTIPORA CAPITATA (Abstract ID: 28967)

Identifying sources of coral pathogens and understanding environmental risk factors is important for predicting and mitigating coral disease outbreaks. In Hawaii, Montipora White Syndrome (MWS) is a tissue loss disease with numerous outbreaks occurring in Kaneohe Bay during the winter when heavy rain events are more common. The bacterium, Vibrio coralliilyticus strain OCN008, has been shown to cause acute tissue loss consistent with MWS. In order to identify sources of this pathogen in Kaneohe Bay, seawater, terrestrial freshwater/sediment, and marine organisms were sampled and tested for the presence of OCN008. In addition, manipulative experiments were conducted to determine if decreased salinity increased disease risk for corals by reducing the amount of bacteria needed to cause infections. OCN008 was detected in freshwater and several marine organisms, including gobies, corallivorous butterflyfish, coral-associated invertebrates, and the coral host (Montipora capitata). Manipulative experiments showed that exposure to decreased salinity did not create lesions in corals but the decreased salinity allowed OCN008 infections to occur at a lower dose (106 cell/mL vs. 108 cells/mL). OCN008 was found in multiple biotic and abiotic sources in Kaneohe Bay, suggesting that corals have many opportunities for exposure to this pathogen. We also found that adverse environmental conditions that lower salinity (e.g. heavy rainfall) could make M. capitata more susceptible to infection by V. coralliilyticus strain OCN008 and offer insight for predicting disease outbreaks in Kaneohe Bay.

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MESOSCALE EDDIES INCREASE LARVAL GROWTH AND SHAPE PATTERNS OF MORTALITY AND RECRUITMENT IN CORAL REEF FISHES (Abstract ID: 29746)

Like most benthic marine organisms, coral reef fishes produce larvae that traverse open ocean waters before settling and metamorphosing into juveniles. Where larvae are transported and how they survive is a central question in marine and fisheries ecology. While there is increasing success in modeling larval trajectories, our knowledge of the physical and biological processes contributing to larval survivorship during dispersal remains relatively poor. Mesoscale eddies, ubiquitous throughout the world's oceans, can exhibit increased productivity in addition to providing a mechanism for retention, suggesting they may serve as important larval habitat. Yet there is a lack of empirical data on growth and survival of larvae associated with these features. We sampled larvae of five coral reef fishes inside and outside of mesoscale eddies and, for three species, tracked cohorts from the plankton to nearshore reefs. Otolith microstructure analysis revealed that four of five species of reef fish examined had consistently faster growth inside of eddies. Additionally, in comparisons of young and old age groups,*Thalassoma bifasciatum* exhibited trait-based selection that varied spatially and temporally. Importantly, larvae of *T. bifasciatum* and *Cryptotomus roseus* that encountered eddies, not only grew faster, but also preferentially survived to settlement. These results indicate that larvae retained in mesoscale eddies likely contribute disproportionately to population replenishment. Successful dispersal in oligotrophic waters may rely on larval encounter with such oceanographic features.

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SEA SURFACE SALINITY VARIABILITY AND PALEOCLIMATE RECONSTRUCTIONS IN CUBA INFERRED FROM CORAL ARAGONITE d18O, d13C AND SR/CA (Abstract ID: 30100 | Poster ID: 7)

Coral geochemical records such as stable isotopic compositions and elemental ratios can provide high-resolution records of past climatic conditions and variability. Such records can elucidate our understanding of climate variability over timescales ranging from inter-annual to centennial, documenting variability associated with seasonality as well as phenomena such as the North Atlantic Oscillation (NAO). Coral paleoceanographic reconstructions are of particular value in the Atlantic basin because of the paucity of data currently available. In Cuba, the largest island in the Caribbean, there is limited instrumental data and limited knowledge of multi-decadal climate sensitivity. Cuba is also an interesting site to study seasonal variations in corals because the annual SST range is high and its shallow platform exhibits high salinity and density gradients. Here we present new results from a 227 year coral core collected in February 2015 from a Siderastrea siderea colony in the Golfo de Ana Maria, in the Southern Cuban coast. This core represents the first long core ever collected in Cuban waters. We present high temporal-resolution measurements of Sr/Ca and d18O that provide historical information about sea surface salinity and SST. Our results fill a void in paleoclimate reconstructions in this region and provide the potential to be integrated into a Caribbean-wide framework for greater understanding of past and future climate variability. This research also exemplifies the opportunities now available from bilateral collaborations between Cuban and American scientists.

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SANTA CRUZ CABRALIA REEFS, BAHIA BRAZIL: USING DIGITAL TOOLS AND PRINTED MEDIA TO RAISE CONSERVATION AWARENESS IN K-12 EDUCATION (Abstract ID: 29121)

Brazilian coasts have the only coral reefs of the South Atlantic, and reefs are in relative good condition. Southern Bahia is home to the largest and most biodiverse reef systems and the coastal reefs of Santa Cruz Cabralia are intensely visited, but still poorly studied. Coral Vivo ("Living Coral") carried out physical mapping and partnered with the K-12 Terezinha Scaramussa State School in an environmental education activity, where students interviewed elder fishermen, many their own relatives, to learn the names of different areas on the reefs. Reef names were about to be lost, as traditional fishing loses importance. Students then christened areas not mentioned. Place names were identified over a WorldView-2 satellite image, which has a 1.85 m pixel for the 6 bands of the visible electromagnetic spectrum fused to 0.46 m resolution pixels of the pan-chromatic band. Imagery was geo-referenced in detail, and the public easily recognized sites. A bathymetry survey was conducted along an 800 km course, consisting of 175 parallel lines 4.5 km long, spaced 100 m. 3,253,013 sounding points, spaced roughly every 0.6 m, were corrected for tidal variations and interpolated into a digital bathymetry model that indicates the relief of the seabed, showing reef morphologies and depth. As a result, a printed poster depicting names, imagery, and relief, with 3-D views featuring depths represented by a color scale was created and distributed to public schools of Southern Bahia's coastal towns (also available at http://coralvivo.org.br/wp-content/uploads/arquivos/2198file-3.pdf).
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IN SITU TEMPERATURE PROFILE OF SHALLOW REEF COMMUNITIES IN NEGROS AND APO ISLAND: 2013-2014 (Abstract ID: 28847 | Poster ID: 352)

Coral reefs provide a wide variety of ecosystem services and goods that benefit humankind. However, the survival and health of reefs are threatened by natural and anthropogenic factors such as climate change and pollution. Increased seawater temperature often results in bleaching of certain coral species. This study aimed at profiling in situ temperature of shallow reef communities in Apo I. and Sibulan, Negros I. from March 2013 to February 2014 using data loggers programmed to record hourly. Results for Apo showed temperature peaks in the months of May, June and July 2013. For Sibulan site, peaks were observed in May, June and September 2013. Lowest temperature for both sites was observed in February 2014. Comparison with satellite-derived sea surface temperatures (SST) for the Bohol Sea indicated Apo Island recorded lower temperatures by 0.5 to 1.5 °C except for the months of October, November and December whereas in Sibulan site, logger-derived temperature recordings were mostly higher by 0.5 °C in the months of March, May, October, November, December 2013, and February 2014. Between sites, variation may be explained by differences in coastal profiles, depths of reefs and influences of different water current systems. Variation from satellite-derived data may be due to depth differences since the latter are taken only from the surface. Continuous in situ temperature monitoring is recommended as it provides a more localized profile especially in this period of changing climate.

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DIVING INTO THE DEEP-END: BAITED REMOTE UNDERWATER VIDEO STATIONS (BRUVS) TO STUDY DEEP-REEF FISH IN THE GREAT BARRIER REEF, AUSTRALIA (Abstract ID: 28024)

Underwater video has great utility to study harder to sample areas such as deeper reefs. Baited Remote Underwater Video Stations (BRUVS) and multi-beam bathymetry were

used to investigate deep-reef fish communities off the continental slope in the Great Barrier Reef, Australia. BRUVS were deployed between 50-300m and fish species richness and diversity were recorded using Australian Institute of Marine Science (AIMS) software. There were significant differences in fish assemblages across depths, with different dominant families and groups of species characterising broad depth categories. For the particular reefs studied, multi-beam habitat derivatives such as depth, rugosity and slope were correlated with higher species diversity and greater abundance. This study resulted in novel records for fish species recorded elsewhere in the Indo-Pacific at similar depths and also identified potential new species. BRUVS have proved useful as a fishery-independent method to survey fish communities, to identify potential "hot-spots" of biological diversity and new species, and to explore surprisingly diverse deep reefs.

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MONITORING SEDIMENTATION AND SEDIMENT ACCUMMULATION RATES FOR PROTECTION OF CORAL REEFS IN COASTAL WATERS (Abstract ID: 28798)

Sediment accumulation rates are essential tools for the understanding of processes related to the deposition of organic and inorganic materials in aquatic environments. They are useful for paleo-environmental reconstructions of climate history or for biotic evolution as seen in the fossil record, and for the functioning of benthic organisms. The isotope method, based on analysis of changes in 210Pb activity in the sediment profile from the coastal waters of the Niger Delta was deployed and Sediment Accumulation Rates calculated using the Constant flux. The Constant Sedimentation Rate, CSR model for isotopic methods was used and age of sediment layers determined using the Constant Rate of Supply, CRS model. This model assumes a constant flux of 210Pb from decay of atmospheric 222Rn followed by adsorption on suspended particulates that carry the 210Pb to estuarine sediment at constant rate. Sedimentation rates estimated from the excess 210Pb profiles of the cores ranged from 0.04 g/cm2/yr before 1976 to 0.16 g/cm2/yr after 1976. Sediment accumulation rates showed minimal variation between 1930 and 1970 but became unstable in the region with leaps from the 1980s reflecting the heightened oil production activities. This has since been exacerbated by the disappearing mangrove. Prediction of possible reclamation of most of the littoral waters of the regions was made and its possible consequences on ecosytem coral reef health are discussed with recommendations for integrated coastal zone management. Key words: Sedimentation rate, Bonny Estuary, Ecological consequences, Paleo-environment, Constant Rate of Supply Model, Coastal Management

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SCALING UP FROM ORGANISMS TO ECOSYSTEM: INDIVIDUAL AND COMBINED COMMUNITY METABOLIC RESPONSES OF FOUR DISTINCT BENTHIC ASSEMBLAGES TO NUTRIENT ADDITION (Abstract ID: 29062)

Reef metabolism experiments are useful for understanding the net ecosystem response of coral reefs to environmental change; however, relating community response to organismal response is challenging. To scale up from organisms to ecosystems, reef metabolism experiments often extrapolate a community response by adding metabolic rates together from individual incubations; an additive design that assumes that the functional relationship between each organism and the environment must be the same. Using a nutrient addition experiment, we measured the impact of elevated nitrate (N) and phosphate (P) on metabolic rates of individual taxa and combined reef communities to test if the relationship between individual and community metabolism is indeed additive. Our reef community consisted of the dominant substrate types found on coral reefs: macroalgae, coral, reef rubble, and sediment. We performed a nutrient press experiment, delivering elevated N and P at a constant rate using peristaltic pumps to three different nutrient concentrations: ambient (N = 0.12 μM, P = 0.05 μM), elevated (N = 2.21μM, P = 0.93 μM), and highly elevated (N = 5.54 μM, P = 1.89 μM). After a 6-week acclimation period, we calculated net ecosystem calcification, net community production, nutrient uptake, and pH feedbacks from the substrates as individuals and as mixed communities over two sequential 24-hour incubation periods. Our results will help us understand how reef organisms and communities respond to eutrophication as well as help to elucidate the scaling of metabolic rates from reef organisms to communities.

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VIRUSES AS RESERVOIRS OF BACTERIAL VIRULENCE GENES IN CORAL REEFS (Abstract ID: 28845)

Marine viruses significantly impact microbial diversity and function through predation and gene transfer. The responses of coral reef bacterial communities to anthropogenic disturbance will be, therefore, tightly liked to viral community dynamics in these systems. Here we investigated genetic diversity of viral assemblages in the Abrolhos Bank coral reefs, the largest reef system in the South Atlantic, currently undergoing benthic phase-shifts, bleaching and disease outbreaks. Most of the bacteriophage sequences in the viromes had high similarity with phages implicated in lysogenic conversion of their hosts. One of the most abundant genes was *lom*, lambda outer membrane protein, which is known to confer pathogenicity to Enterobacteria. Analysis of assembled contigs containing the *lom* gene indicate that its high abundance is not due to dominance of one single viral strain containing the gene, instead, *lom* is found in the genomes of many different phage strains. We provide evidence that this gene is being laterally transferred and positively selected within the bacterial community. Lysogenic conversion of symbionts associated to coral reef organisms could be the cause of disease outbreaks observed in reefs around the globe, a well-known mechanism in human pathogens such as *Vibrio cholera* and recently proposed in the coral pathogen *Vibrio coralliitycus*.

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LARVAL DEVELOPMENT AND RECRUITMENT IN *PTEROGORGIA GUADALUPENSIS* UNDER ACIDIFICATION CONDITIONS (Abstract ID: 29960 | Poster ID: 198)

Although we understand the effects of ocean acidification on adult populations of octocorals, little is known about its effects on the early life stages. For octocorals, there is evidence of resilience against ocean acidification under mesocosms conditions but the effects on larval development and recruitment are unknown. In this study, we grew larvae of the brooder gorgonian coral from the Caribbean *Pterogorgia guadalupensis*(Gorgonidae: Octocorallia) under laboratory conditions and bred the larvae to follow their complete development and metamorphosis through the polyp stage, under acidification conditions. We describe the life history of this octocoral, follow its development rates and survival, and finally, evaluate 1) larval recruitment under decreased pH conditions and 2) larval preferences and affinity for two settlement surfaces including coralline red algae and dead gorgonian axis. Treatments with decreased pH conditions did not affect significantly either larvae survival or the development processes, but they did affect recruitment and settlement rates. We found high preferences of the larvae for coralline red algae as settlement surface, showing that it significantly improves larval recruitment even at low pH. Our results suggest that although acidified environments reduce larvae recruitment in *P. guadalupensis*, coralline red algae can significantly aid in overcoming this effect and produce greater numbers of successful polyp recruits.

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MONITORING ALGAL DIVERSITY IN THE WESTERN PACIFIC: A CASE STUDY ON *ACTINOTRICHIA* (Abstract ID: 29986 | Poster ID: 50)

Introduced algae are an important focus of resource managers because of their potential to become invasive and have devastating impacts on reef ecosystems. To assess the risk of introducing non-indigenous marine species (NIMS) and monitor those already present, an understanding of the current diversity and distribution of the flora is required. Traditional (morphological) identification can be expensive and often inaccurate, but recent genetic techniques – like DNA barcoding - provide fast and cost-effective methods for algae identification and cryptic species recognition. In this study, we use the red algal genus *Actinotrichia* Decaisne to examine algae species diversity in Micronesia and the western Pacific. Sequence analysis using the mitochondrial marker COI-5P and plastid marker rbcL indicates a high degree of cryptic diversity in *Actinotrichia*, with two new and undescribed species present in Micronesia's flora alone, and potentially many more throughout the Indo-Pacific. These results suggest the marine flora of these regions is substantially more diverse than currently recognized, and further study of this diversity will aid resource managers in monitoring NIMS and potentially harmful invasive species.

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TROPHIC SPECTRUM ANALYSIS OF REEF FISHES IN TWINROCKS MARINE SANCTUARY, NORTHERN VERDE ISLAND PASSAGE, PHILIPPINES (Abstract ID: 28639 | Poster ID: 635)

Against the backdrop of increasing disturbances due to human-dominated environments, coral reef ecosystems are in constant threat. One useful method in defining the health of coral reefs is through trophic spectrum analysis of reef fish community. This method shows the distribution of reef fish assemblage to a continuum of trophic fractions, which can indicate the structure and functioning of aquatic ecosystems in a fisheries context. This study aims to identify the effects of coral reef protection to the trophic spectrum of its associated fish assemblage. In the study, Twin Rocks Marine Sanctuary of the North Calumpang Peninsula was monitored for seven months. Standard fish visual census, coupled with benthic phototransect method was conducted on established permanent transects. Overall, there was a total of 236 species under 38 families of reef fishes observed throughout the duration of the monitoring period. For each species identified, fractional trophic levels were assigned based on their classification in FishBase.org. Mean biomass of reef fishes across trophic levels was consistently higher inside the marine sanctuary. This difference was most evident for herbivores and mobile invertebrate feeders, which were mostly commercially important reef fishes in the study site. Furthermore, there were more facultative piscivores and schooling reef fishes inside the reserve compared to its adjacent outside boundary. The results showed the utility of trophic spectrum analysis in reflecting the benefits of protecting coral reef areas. http://ibs.uplb.edu.ph

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FITTING A PIECE IN THE SOUTH ATLANTIC PUZZLE: SEAMOUNTS AS STEPPING-STONES BETWEEN MAINLAND AND OCEANIC ISLANDS (Abstract ID: 28468)

The puzzling pattern that arises from the disjunct distribution of tropical reef fishes in the South Atlantic indicates that stepping-stone habitats are not required for ocean-wide dispersal, but they may be important for short routes between oceanic islands and mainland. Trindade and Martin Vaz, 1,200 km off the Brazilian coast, are the only exposed peaks of a volcanic ridge, the Vitória-Trindade Chain (VTC), and show high species richness when compared to other remote islands of the Atlantic. The seamounts of the VTC, which summits today are in mesophotic depths (average 50 m), have been suggested to serve as stepping-stones between the continental shelf and the islands. A comparative phylogeographic approach was used to understand the role of seamounts for fish diversity on islands, helping solve the South Atlantic puzzle. Two reef fishes collected throughout the VTC were analyzed for both mtDNA (cytochrome b and control region) and nDNA (8-12 microsatellite loci) markers. Populations from the continental shelf and seamounts have undergone severe bottlenecks associated to habitat loss during glacial low sea level stands, while those from the islands apparently experienced more stable conditions. A clear signal of isolation by distance was found in the species with lower dispersal ability, evidencing that seamounts are important for increasing the reef fish richness on the remote islands. A biodiversity feedback, controlled by sea level fluctuations, was identified amongst islands, seamounts and mainland, showing that peripheral locations are not evolutionary graveyards.

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THE ROLE OF CNIDARIAN FICOLIN-LIKE PROTEINS IN *SYMBIODINIUM* RECOGNITION AND UPTAKE (Abstract ID: 27980)

Coral reefs depend upon the functional symbiosis between a cnidarian animal host, the coral, and its intracellular photosynthetic dinoflagellate in the genus *Symbiodinium*. Understanding cnidarian-dinoflagellate symbiosis has been the effort of decade-long research, yet the molecular principles governing this association are still largely undescribed. The recent sequencing of the genome of the sea anemone *Aiptasia* revealed a highly promising set of proteins that might function through the lectin-complement pathway and contribute to the selection of "compatible" *Symbiodinium* types. These proteins share the canonical ficolin structure, containing terminal collagen- and fibrinogen-like domains, and are exceptional for the presence of central tandem immunoglobulin domains. Given the absence of these proteins in bilaterians, they have been named Cnidarian Ficolin-Like proteins (CniFLs). Interestingly, CniFLs have so far been identified only in symbiotic cnidarians and their gene expression in *Aiptasia* is differentially regulated upon symbiosis establishment, suggesting a role of CniFLs in *Symbiodinium* recognition and uptake. The present work aims to elucidate the putative CniFLs–associated complement pathway that mediates the uptake of *Symbiodinium* in *Aiptasia*. To this end, we use targeted-proteomic approaches to identify putative CniFLs-binding molecules exposed on the *Symbiodinium* surface and detailed biophysical characterization to investigate the nature of the interactions.

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GLOBAL FINPRINT: THE FIRST GLOBAL SURVEY OF SHARKS AND RAYS ON CORAL REEFS (Abstract ID: 29112)

Over the past half century there has been a substantial decline in the abundance of sharks on many of the world's coral reefs. Fishing has been the main cause of this decline, with the proximity of human communities often identified as a key risk factor for these declines. The ad hoc reporting of declines and the use of a range of sampling techniques, has limited our understanding of the magnitude of the declines and the appropriate conservation responses. To provide a clear picture of the global status of sharks associated with coral reefs the Global FinPrint project was established in 2015. The project is using new and existing baited remote underwater video (BRUV) data to examine the diversity and abundance of sharks and rays at hundreds of coral reef locations in the Pacific, Indian and Atlantic Oceans. This presentation will describe the objectives, sampling design, opportunities for partners and intended outcomes of the project. An update on the first year of sampling will be provided.

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SOUNDTRACK OF THE ANTHROPOCENE: IMPACTS OF GLOBAL CHANGE ON LARVAL RECRUITMENT IN THE 21ST CENTURY (Abstract ID: 28369)

In early life, the vast majority of coral reef organisms face four major tests that together determine dispersal, survival and population replenishment. Since larvae generally develop away from reef habitat, once sufficiently well developed to leave open water environments, they must locate reefs, select suitable habitat, settle at locations with sufficient shelter, and avoid the immediate attention of many voracious predators. Over the past 15 years we have discovered the importance of the natural soundscape (combined with other cues) for guiding fish, crustacean and coral larvae towards reefs while allowing them to avoid predation. Reef noise is generated by the resident community, so reefs sound characteristically different and sound indicates the composition of the community and quality of the habitat, enabling larvae to locate and settle into appropriate microhabitat. But we live in an era of global change, with overfishing and pollution compromising reef quality, rising levels of atmospheric CO2 causing ocean acidification, and the noise of motorboats, ships, offshore industry and naval operations modifying natural soundscapes. Our recent work demonstrates that ocean acidification can affect auditory behaviour of larvae, and that motorboat noise can affect orientation and settlement in larval fish, and behaviour, physiology and survival of newly-settled reef fish. Following a summary of these studies, I will conclude with discussion of ways in which we may mitigate the impacts of global change on larval recruitment in the 21st century. http://biosciences.exeter.ac.uk/staff/index.php?web_id=Stephen_Simpson

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BIOGEOGRAPHY OF DINOFLAGELLATE SYMBIONTS ACROSS THE INDO-PACIFIC: AN ECOLOGICAL AND EVOLUTIONARY ANALYSIS (Abstract ID: 28508 | Poster ID: 77)

Biogeographic studies have shown that the dinoflagellate symbionts (Symbiodinium) that inhabit corals exhibit variation in distribution across both broad geographical and local scales. Moreover, modern molecular techniques revealed that Symbiodinium types within a single clade differ in traits such as host specificity, niche diversification, physiology or bleaching susceptibility. This has provoked the need for further investigations into the distribution and evolutionary patterns of Symbiodinium at fine taxonomic scales, particularly in congruence with coral host and environmental data since both are

considered equally important driving factors for Symbiodinium diversity and speciation. We assembled a database of several thousand occurrences of Symbiodinium at the sub-clade level from across the Indo-Pacific that included environmental data, symbiont sequence data, symbiont host data and host trait data. We investigated how environmental factors in combination with evolutionary processes and ecological traits structure present day Symbiodinium species assemblages and influence their distribution across the Indo-Pacific. Furthermore, we tested whether biogeographic breaks in Symbiodinium sub-clades are concordant with current understanding of Indo-Pacific coral faunal breaks, evolutionary processes and community composition, providing insight into the ecological and evolutionary patterns of these symbiotic partners.

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GROUNDWATER-MEDIATED ANTHROPOGENIC NUTRIENT INPUTS TO A NEAR-SHORE REEF ON BERMUDA (Abstract ID: 30039 | Poster ID: 456)

Groundwater discharge is increasingly recognized as a source of nutrient pollution to coastal reefs around the world, but much has yet to be learned of the extent and severity of its effects on water quality and reef ecology. Most of the sewage generated by Bermuda's 65,000 residents (national population density of 1,200 people/km2, third-highest in the world) enters the groundwater through untreated cesspits. Despite extreme nutrient loading in the groundwater, the impact of groundwater discharge on Bermuda's coral reefs has been little studied. We surveyed submarine groundwater discharge on a patch reef, 0-30m from shore, in Tynes Bay, adjacent to a large groundwater lens. Temperature, salinity, pH, and alkalinity were monitored at the discharge site, on the adjacent reef, and 30m from shore. Groundwater discharge, characterized by low salinity, high alkalinity, elevated nitrogen concentrations (500µM NO3– + NO2–, 2.5µM NH4+) and an elevated 15N/14N ratio (δ15N=10.9‰) consistent with inputs of human waste, was strongly linked with rainfall and tidal cycles. On the adjacent patch reef, NO3- + NO2- averaged 5µM, 10 times higher than typical in central Tynes Bay. Despite this heavy localized nutrient loading, coral calcification rates and percent live coral cover on the patch reef are relatively high, and bioerosion rates are lower than they are on Pacific reefs with comparable nutrient concentrations. Understanding reef community functionality under these conditions is critical to the design of reef management strategies in densely populated areas.

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SOCOTRA: THE NEW HYBRID HOTSPOT (Abstract ID: 28304 | Poster ID: 37)

Areas where closely related species of reef fish from different biogeographical regions come into contact and interbreed to form hybrids are known as suture zones. Here we characterise a previously unknown suture zone in the Western Indian Ocean at the Socotra Archipelago (Yemen), where fish fauna from the Red Sea, Gulf of Aden, Arabian Sea, and greater Indo-Polynesian province intersect. The rate of hybrid discovery at Socotra (based on the number of dives and areas explored per hybrid crosses detected) surpasses that recorded elsewhere in the tropical marine environment. Here we present morphological, behavioural and genetic evidence of hybridisation involving 14 species of reef fish. We suggest that a unique combination of; location at the intersection of multiple biogeographic provinces, abundant reef habitat, fluctuating environmental conditions, and differences in sister species abundance are responsible for the level of hybridisation reported in Socotra. Given our limited search time, we predict that the extent of hybridisation occurring at Socotra will ultimately be even greater than reported here, highlighting the prospect of Socotra as a producer or genetic novelty and new diversity.

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DETECTION OF MOLECULAR STRESS RESPONSE IN CORALS EXPERIENCING CHRONIC CONTACT WITH INVASIVE ALGAE MATS (Abstract ID: 29794)

Increasing human development and activity around tropical coastlines exposes coral reefs to a host of local stressors (overfishing, sedimentation, nutrification), which act synergistically to decrease coral cover, health, and recruitment, while encouraging the growth and proliferation of macroalgae. Contact with macroalgae has been shown to cause coral bleaching, disease, and reduced growth and fecundity through shading, abrasion, oxidative stress, allelopathic interactions and alteration of the coral microbiome. Few studies have investigated the stress response of corals in chronic contact with algae, and none have used molecular methods to do so. This study focuses on finger coral (Porites compressa) colonies in naturally occurring, chronic contact with the invasive red carrageenophyte alga, Kappaphycus alvarezii, on patch reefs in Kaneohe Bay, Oahu, Hawaii. Shotgun proteome sequencing, targeted immunoblotting, and enzyme activity assays indicate that P. compressa corals experience oxidative stress and reduced metabolic health when in long term, chronic contact with invasive Kappaphycus sp. mats. This study demonstrates the use of molecular methods in identifying and characterizing stress in outwardly healthy corals, allowing for more proactive management of at-risk coral reef ecosystems, and lays the foundation for understanding mechanisms of acclimation and resilience to algae-induced stress. Comparison with the stress profiles of corals experimentally exposed to acute algal contact stress will provide further insight into ecologically relevant coral stress responses.

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DEVELOPING A NOAA CORAL GENOMIC OBSERVATORY NETWORK (CGON): PRELIMINARY METAGENOMIC PILOT STUDIES AND CGON DEVELOPMENT PLANS (Abstract ID: 29763)

NOAA is in the early stages of developing a "Coral Genomic Observatory Network" (CGON) to complement the NOAA "Integrated Coral Observing Network" (ICON). This new CGON initiative intends to establish observatories in critical coral reef ecosystems for meta-'omic characterization of community DNA and RNA for functional and taxonomic genes of both coral and its holobiont microbiomes. CGON research seeks to better understand resilience and adaptation of corals to climate-related and anthropogenic stress, such as temperature, nutrients, and disease stressors. The early phase of this CGON initiative focuses on selected sentinel reef sites in the Florida Keys National Marine Sanctuary, in the urbanized coastal waters of SE Florida, and in "relatively pristine" waters of Little Cayman, allowing comparisons of reefs with high direct anthropogenic influence and a reef with minimal direct anthropogenic influence. A small-scale preliminary pilot study in advance of CGON was conducted (and is reported here) for 4 sentinel reef sites in the urbanized coastal waters of Miami-Dade and Broward Counties (Florida, USA). This pilot study only represents 16S bacterial taxonomic metagenomics, rather than full meta-'omic characterization, for two species of coral, as well as qPCR-based microbial source tracking of fecal indicating bacteria, for these coral reefs and for coastal inlets and wastewater outfalls impacting them. The CGON initiative is expected to enhance the genetic information for these sites and to eventually expand such characterization to other reefs around the world.

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HIGH BIODIVERSITY OF MESOPHOTIC CORALS IN OKINAWA AND ITS IMPORTANCE IN A CHANGING WORLD. (Abstract ID: 29422)

In the Northwestern Pacific, the Kuroshio Current supplies warm tropical water to the Ryukyu Archipelago in Japan providing good conditions for a high diversity of coral species. However, as for most coral reefs worldwide, the biodiversity of Japanese mesophotic corals remains virtually unknown. Here we report the preliminary observations of the coral distribution and diversity at several sites along the archipelago at depths from 30 down to 100 m. The coral cover and community structure were estimated using photoquadrats, while detailed coral identification was based on morphological and molecular examination of samples. An important diversity of distinct coral communities was found throughout the archipelago combined with high coral species diversity. Coral coverage is usually low, although occasionally, coral coverage can be nearly total. However, the highest coral coverage was usually associated with low species diversity.

*Leptoseris*, the emblematic mesophotic coral genus, dominated communities mainly in protected bays of the Southern part of the archipelago. Other communities were dominated by *Pachyseris*, *Acropora*species, *Seriatopora hystrix*, and other anthozoans (e.g. corallimorphs). Except for the *Leptoseris*-dominated communities, most of the dense coral communities were found only from one location. This suggests that not only MCEs in the Ryukyu Archipelago are very diverse both at species and community level, but also that this diversity is still largely underexplored. We will discuss the significance of these findings in a conservation perspective.

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THE DAWNING OF THE MESOPHOTIC REEF RESEARCH IN THE PHILIPPINES (Abstract ID: 29059 | Poster ID: 326)

The Philippines has among the largest and most biodiverse reef areas in the world. However, most of its shallow reefs outside marine protected areas have gradually declined over the decades while its mesophotic reefs at depths of 30–150 m have scarcely been studied. In this study, six sites from different parts of the Philippines were surveyed for documentation of the occurrence of coral ecosystems at the upper mesophotic depths. Multibeam and side scan sonars were used to map the sea floor and to identify sites for SCUBA dives, drop-camera and ROV surveys to identify biodiversity and ecological patterns. These provided an initial inventory of corals and fishes, information on the locations of high biodiversity, and emergent patterns on the differences between shallow and mesophotic reef communities. Here we present a synthesis of the initial results of the first nationwide mesophotic exploration in the Philippines and a framework of management of mesophotic coral reef resources.

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RESPONDING TO FISH EXTIRPATIONS IN THE GLOBAL MARINE BIODIVERSITY EPICENTRE (Abstract ID: 28060)

The Philippines lie in the global marine biodiversity epicentre but the ecological footprint of their reef fishing is fourth highest among island nations. Fisheries landings are declining, yet the status of the most vulnerable species is scarcely known. Localised species extinctions have been detected at Bohol Island but wider survey effort has been lacking. This is the first multidisciplinary study of national scope to identify species at risk of extirpation, using local and scientific knowledge to accurately infer declines in this data-poor setting. Semi-structured interviews to capture fishers' knowledge and identify declining reef species were followed by well-replicated UVC in 5 marine KBAs, targeting shallow water fishery target species reported to have disappeared from catches between the 1950s and 2014. Five species suffered a decline in CPUE of 64-88%: bumphead parrotfish, humphead wrasse, African pompano, giant grouper and mangrove red snapper. They were also absent from the UVC surveys, in addition to 6 other target species. Fishing pressure was not a factor but massive coral and complexity were predictors of spatial variation in the assemblage. The dramatic declines in CPUE over several decades and the absence of 21% of the target species in UVC data indicate a substantial prior decline in target populations. Contrasting patterns in fish presence/absence between fishers' catch and UVC data underline the importance of using multiple methods to accurately assess past changes in and current status of populations.

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FROM MESOCOSM EXPERIMENTS TO SATELLITES: IMPLEMENTING THE LIGHT STRESS DAMAGE PRODUCT SUITE FOR TRACKING CORAL PHOTOSYSTEM HEALTH. (Abstract ID: 29145)

The world's only global operational satellite product designed specifically to monitor coral bleaching thermal stress is the HotSpot product suite, developed by the National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Watch (CRW) program. These products help coral reef managers map and monitor heat stress remotely and hence better understand and predict mass coral bleaching. Although these products perform quite well when used to describe the onset of bleaching, they provide only indicative measures of the severity, duration and associated mortality of a bleaching event. They also do not separate the different responses of various coral genera, which is increasingly important as the mix of genera on reefs continually alters due to the loss of less tolerant genera via past stress events. The HotSpot product suite is based only on sea surface temperature (SST). However, we now know that mass coral bleaching results from the combined effect of temperature and light and that bleaching response varies between genera. Here we describe a major evolution of the NOAA CRW satellite products. Called the Light Stress Damage (LSD) product suite, it combines satellite-derived SST and solar insolation data to provide improved measures of stress to coral health. The LSD is designed to provide an improved prediction of the severity and mortality associated with bleaching events and should also provide a more accurate measure of the onset and end of a coral stress event. It also will allow for measurement of different bleaching responses between genera.
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BUTTERFLYFISHES EXHIBIT SPECIES-SPECIFIC RESPONSES TO CHANGES IN PACIFIC SOFT CORAL COMMUNITIES (Abstract ID: 28189)

Many butterflyfish species exhibit feeding preferences for scleractinian corals that represent a continuum from facultative to obligate strategies, and which affect their predicted responses to temporal and spatial changes in coral community structure. Less frequently studied are interactions between butterflyfishes and soft corals, even though the latter represent significant habitat and energetic resources on Indo-Pacific coral reefs. We examined changes to the benthic community structure of three disjunct back-reef communities on the leeward side of Guam over two decades. These communities include a reef that has remained stable and relatively pristine through time, a reef that was significantly impaired but has stabilized over time, and a reef that has experienced a shifting baseline in response to anthropogenic and natural disturbances during this period. Benthic community structure, including soft corals, was monitored from 1994-2014. Density and behavior of six species of butterflyfishes, including an obligate hard coral specialist, two soft coral specialists, and three generalists of varied dietary breadth, were recorded at each of the sites in 1994, 2004 and 2014. The populations of butterflyfishes varied through time and space, and there were significant changes in foraging behaviors, largely due to changes in the soft coral community. Moreover, our results indicate that

the soft coral specialists exhibited differential prey preferences that were directly attributable to their ability to handle soft coral chemical defenses.

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"SUPER-QUENCHING" STATE PROTECTS SYMBIODINIUM FROM THERMAL STRESS: IMPLICATIONS FOR CORAL BLEACHING. (Abstract ID: 29338)

The global rise in sea surface temperatures causes regular exposure of corals to high temperature and high light stress, leading to worldwide disastrous coral bleaching events (loss of symbiotic dinoflagellates (Symbiodinium) from reef-building corals). Our picosecond chlorophyll fluorescence experiments on cultured Symbiodinium Clade C cells, exposed to coral bleaching conditions, uncovered the transformations of the alga's photosynthetic apparatus (PSA) that activate an extremely efficient non-photochemical "super-quenching" mechanism. Ultrastructural investigation of the thylakoid membranes under these elevated temperature conditions support a disaggregation of the formerly structured arrangement as has been found in other investigations. Thus the mechanism is associated with a transition from an initially heterogeneous photosystem II (PSII) pool to a homogeneous "spillover" pool, where nearly all excitation energy is transferred to photosystem I (PSI). There, the inherently higher stability of PSI and high quenching efficiency of P700+ allow dumping of PSII excess excitation energy into heat, which can result in almost complete cessation of photosynthetic electron transport (PET). This potentially reversible "super-quenching" mechanism protects the PSA against destruction at the cost of a loss of photosynthetic activity. We suggest that the inhibition of PET and the consequent inhibition of organic carbon production (e.g. sugars) in the symbiotic Symbiodinium provide a trigger for the symbiont expulsion, i.e. bleaching. However, other processes, such as ROS production from the Mehler reaction may also occur and cause irreversible damage to PSII

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UNITED STATES CORAL REEF TASK FORCE WATERSHED PARTNERSHIP INITIATIVE (Abstract ID: 29646)

The United States Coral Reef Task Force (USCRTF) created the Watershed Partnership Initiative (Initiative) in 2009. The Initiative facilitates and enhances coordination, partnerships, and contributions of agency resources and expertise to implement geographically specific and integrated activities to reduce pollutant loads to coral reef ecosystems. The Initiative uses this approach in three selected priority watersheds (Guánica Bay/Rio Loco in southwest Puerto Rico, West Maui, Hawaii, and Faga'alu in American Samoa) with the intent for future application to other watersheds with likelihood for success. Individual federal, state, territory, and commonwealth agencies contribute through direct application of resources, authorities, technical assistance, and/or program expertise. The National Fish and Wildlife Foundation (NFWF) also provides funding assistance and coordination, develops relevant tools, and seeks to identify and fill gaps. The Initiative developed a series of goals, objectives, and actions which are implemented by the USCRTF Watershed Working Group (Working Group). The Working Group consists of staff from member agencies and jurisdictions, NFWF, and USCRTF priority and jurisdictional watershed coordinators. They meet monthly to implement a USCRTF resolution, and support watershed efforts and federal partnerships watersheds. A Metrics Subcommittee was formed to develop an approach to evaluate efforts of the Initiative and has been working collaboratively to develop tools and products to help document success at the priority watersheds.

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IMPAIRED ALGAL TISSUES REGAIN LOW ARGININE LEVELS AFTER SHORT TIMECOURSE IN LOW NUTRIENT WATERS. (Abstract ID: 30035)

Tainted submarine groundwater discharge (SGD) has lead to substantial nutrient loading of polluted waters into coastal regions and sustains blooms of invasive algae in urban Maui, Hawaii. Bloom algae sequester excess nitrogen (N) with high levels of tissue N stored as amino acid arginine (ARG). Diets high in algal tissues with elevated ARG coincide with high incidence of the fibropapilloma disease. In sites with tainted SGD, protected green turtle*Chelonia mydas* graze on invasive weeds with substantial tissue N stored as ARG and are subjected to as much as 14-fold increase, leading to a metabolic promotion of the disease as ARG is a critical component in a Herpes lifecycle. However, it is clear that plants draw down excess N and mobilized it for metabolic needs when subjected to environmental N- limitations. To determine if bloom species can draw on stored tissue N and a possible time-course for that drawdown, we collected invasives from high nutrient sites and transferred them to oligotrophic reefs on Maui or held them in laboratory settings with typical low nutrient waters. Tissues were sampled periodically over two weeks. Plants grown in situ or in laboratory, with little known pollution, had substantial declines in levels of ARG in tissues in relatively short periods; tissue ARG often approached background levels. Thus, reduction in nutrient contamination of SGD to coastal waters can have substantial and rapid impacts on biological systems, even in the short term. These factors are important considerations for management of coastal resources.

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THE GENOMIC BASIS FOR ADAPTATION TO THERMALLY EXTREME REEFS (Abstract ID: 28794)

Elevated sea temperatures have played a crucial role in the global decline of coral reefs and are expected to lead to further declines in the near future. Despite the threat of increased thermal stress due to climate change, corals' capacity to adapt or acclimatise to these conditions remains poorly understood. Corals in the thermally extreme Arabian Gulf currently experience temperatures that exceed those expected on reefs in the tropics within the next century and therefore represent an excellent resource to study the genomic basis for adaptation to high thermal stress environments. In this study, population genomics analyses were performed on Platygyra daedalea, using genome-wide SNPs obtained through double digest restriction site associated DNA (ddRAD) sequencing of corals from 12 reefs in the Arabian Gulf and the more benign Gulf of Oman. We use genome-wide SNPs to describe reduced gene flow between reefs experiencing different thermal regimes at both regional (Arabian Gulf and Gulf of Oman) and local scales (inshore and offshore). The analysis of the genomic distribution of population genetic parameters (e.g. Fst and LD) is used to characterise outlier loci under positive selection in high temperature reefs, identifying genes and pathways responsible for Arabian Gulf corals' thermal tolerance. Furthermore, signatures of selection will be analysed to ascertain whether this thermal tolerance emerged from standing genetic variation or from novel mutations within the Arabian Gulf, thereby providing vital insights into the capacity for corals to respond to climate change.

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DEVELOPING A ZONING DESIGN FOR CONSERVATION, FISHERIES, AND BLUE ECONOMY IN SEYCHELLES. (Abstract ID: 29882)

The Seychelles is a rich, tropical marine ecosystem situated in the Western Indian Ocean. Encompassing 1.37 million square kilometres and 115 islands, Seychelles is a recognised global biodiversity hotspot and contains two UNESCO sites. Biodiversity is one of Seychelles' most important assets and drives the country's Blue Economy. Seychelles has a goal of 30 percent of their Exclusive Economic Zone for conservation and the Seychelles Marine Spatial Planning (MSP) Initiative is focused on developing a coarse-scale, multi-objective zoning design and management considerations for conservation, fisheries, and other uses. The Initiative runs from 2014-2020 and has significant input from stakeholders. To develop a draft zoning design we are using data from multiple sources including academia, government, industry and participatory mapping. Commercial catch data were compiled from the industrial tuna fishery (2003-2012) and semi-industrial and artisanal fisheries (2008-2013). We used Marxan to analyse multi-year datasets from the Vessel Monitoring System, excluding high piracy years, and spatially depict high-medium-low use areas for local fisheries. Using more than 100 conservation features, Marxan irreplaceability values developed by the UNDP-GEF-PCU were used to propose biodiversity zones and check biodiversity representation targets. The zoning design methodology considers ecological design principles for MPAs, coral reef fisheries and designing marine managed areas, policy and management, and design principles to maximise compliance, monitoring and enforcement.

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OCEAN ACIDIFICATION CAUSES ABUNDANCE LOSS OF ZOOPLANKTON LIVING RESIDENTIAL TO CORAL REEFS (Abstract ID: 28486)

Several zooplankton species live completely residential to coral reefs by hiding within the substratum during the day and migrating into the water column at night. Their role in reef trophodynamics is rarely studied and yet they are critical to coral health, reef fisheries production, and nutrient cycling. Even less is known about how entire zooplankton communities living within reefs are affected by the precipitous changes caused by anthropogenic loading of carbon dioxide. Ocean acidification effects on zooplankton have been studied for single-species, mostly calcium carbonate species or dominant copepod species, but community effects are scarcely understood. Here, we examined the abundance and community composition of zooplankton living residential to coral reefs at two reefs in Papua New Guinea where underwater seeps create a natural gradient in pH. Zooplankton were observed on three separate expeditions and at two separate reefs using a variety of methods, including traditional net tows, emergence traps, and acoustical instruments. There was less zooplankton present in the reef affected by ocean acidification (pH 7.8) compared to the healthy reef (pH 8.1), and differences were consistent across reefs and expeditions. Sensitivities varied considerably across taxa, with species like the calanoid copepod *Labidocera bataviae* being more sensitive to ocean acidification than other zooplankton. Zooplankton abundance loss will likely have cascading impacts on entire reef ecosystems.

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TOP-DOWN VERSUS BOTTOM-UP REGULATION OF CORALS IN THE FLORIDA KEYS (Abstract ID: 28057)

Caribbean coral reefs have drastically changed over the past 30 years with declines in coral cover and herbivore abundance. In order to regulate increasing competitive macroalgae, protecting the remaining reef herbivores has become a primary conservation goal throughout the Caribbean. However, this assumes that corals are limited primarily by the top-down indirect effect of herbivores on macroalgae. To test the predictions of this herbivore cascade hypothesis along with alterative bottom-up hypotheses, we surveyed the reef community structure (parrotfish abundance and substrate cover) of 34 reefs in the middle region of the Florida Keys National Marine Sanctuary. Reef physical structure was estimated by the first principle component composite variable (distance from shore, depth, visibility, substrate complexity). We estimated the major influences on percent coral cover using both multiple regression analysis and structural equation modelling. Both methods suggest that there are positive top-down (parrotfish), negative bottom-up (reef structure) and negative competitive (fleshy algae) influences on coral. However, the structural equation models suggest that these are not driven by strong negative interactions of parrotfish on turf or fleshy algae. Analysis of parrotfish foraging behavior suggests that diet composition is highly variable and preferences for algae change with relative abundance. These results suggest that hard corals of the middle Florida Keys may be regulated by a complex interaction of top-down and bottom-up influences independent of parrotfish herbivory.

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ESA-LISTED INDO-PACIFIC CORALS: CHALLENGES AND OPPORTUNITIES (Abstract ID: 29718)

Many reef-building coral species are in decline in both the Caribbean and Indo-Pacific basins from a complex combination of global and local threats. Reef-building corals were first listed under the U.S. Endangered Species Act in the Caribbean in 2006, and in the Indo-Pacific in 2014. ESA-listed Caribbean corals make up a substantial proportion of the basin's coral biodiversity, and include the primary reef-building species. They are also well-studied, easy to identify, and widely distributed in U.S. waters. In contrast, ESA-listed Indo-Pacific corals make up a tiny fraction of the basin's coral biodiversity, and do not include any primary reef-building species. They are poorly studied, hard to identify, and barely occur in U.S. waters. These characteristics increase the challenges of implementing ESA management of the listed Indo-Pacific species. In fact, many experienced coral and coral reef managers and researchers in the U.S. Pacific Islands consider the listings to be an impediment to conservation. However, the Indo-Pacific listings can provide numerous conservation opportunities, if implementation is adapted to meet the challenges. Opportunities exist both via the formal protections applied to all listed species, as well as via the informal support of ongoing and proposed conservation programs and projects. http://www.fpir.noaa.gov/PRD/prd_coral.html

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TO CULL OR NOT TO CULL AN INVASIVE PREDATOR? IT DEPENDS . . . (Abstract ID: 29783)

Culling is commonly used in conservation as a means to eradicate invasive species or to reduce their populations to levels that minimize ecological impacts. Culling can be an effective management tool but it is labor-intensive, costly and its effects are sometimes unpredictable. In the Caribbean, culling is widely used to control invasive Pacific red lionfish,*Pterois volitans* , predators that have substantially reduced native prey fish abundances on coral reefs. However, the effectiveness of these control efforts is unclear. We assessed the effectiveness of lionfish culling at varying frequencies in a 21-month-long field experiment on natural reefs in The Bahamas. Surprisingly, culling every 6 months was more effective at reducing lionfish densities than culling every 3 months, resulting in average declines in lionfish densities of 79% and 60%, respectively, relative to unculled reefs. However, these reductions in lionfish densities did not result in gains in native prey fish biomass or species richness, which remained indistinguishable from unculled reefs. Furthermore, lionfish densities were greater on culled than on unculled reefs while native prey fish biomass and species richness were lower on culled than on unculled reefs following Hurricane Irene, and these results persisted for several months following the disturbance. Density-dependent lionfish movement and natural disturbances appear to play a role in limiting the effectiveness of lionfish culling at local scales.

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BLEACHING AND DEPTH REFUGES IN THE EASTERN PACIFIC DURING THE STRONG 2015-2016 EL NIÑO (Abstract ID: 29959)

The ongoing 2015-16 El Niño is third severe El Niño to impact reefs of the eastern tropical Pacific in the last 35 years. In the two previous events communities of the hydrocoral *Millepora intricata* were extirpated from shallow water but survived in deeper water (> 12 m depth), facilitating shallow water recovery between disturbances. This supported the deep reef refugia hypothesis, which posits that cooler temperatures and other physical characteristics buffer corals in deep environments. However, this evidence lacked supporting oceanographic observations, and recent evidence from Caribbean mesophotic reefs suggests that thermal tolerance is set by the mean warmest conditions, allowing bleaching even when conditions are cool relative to shallow reefs. To understand the oceanographic and biological processes that might support or inhibit a depth refuge, we are studying the response of six species of stony coral at depths of 5 – 30 m in Panama and the Galápagos. By August 2015, *M. intricata* had once again been nearly extirpated from shallow water study sites in Panama and other species showed paling, bleaching or early stages of mortality. Below 15 m depth temperatures were cooler and corals were unaffected. From the ultimate response of corals and the physical environment to be sampled during the predicted spring 2016 thermal maximum, we will be able to determine what physical factors support a bleaching refuge. These studies are critical to assessing the importance of refugia in preventing regional and global coral extinction in a warmer future.

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MACROALGAE AND OCEAN ACIDIFICATION CAUSE SHIFTS IN BACTERIAL COMMUNITIES ON CCA WITH IMPLICATIONS FOR CORAL LARVAL SETTLEMENT (Abstract ID: 29547)

Coral recruitment is critical to the maintenance of healthy reefs and the natural recovery of degraded reefs. For some corals, settlement, which is an integral part of the recruitment process, appears to be dependent on the presence of chemical cues produced by biofilm bacteria. Both macroalgal presence and ocean acidification (OA) have detrimental impacts on coral settlement, but the extent to which these stressors impact bacterial communities associated with settlement substrata has been underexplored. Further, these stressors will not occur in isolation, and understanding the implications of these factors in combination is critical. We exposed the crustose coralline alga

(CCA) *Hydrolithon beorgesenii* to direct macroalgal contact and OA separately and in combination. Coral larvae responded differently to CCA surfaces that had been exposed to macroalgae and lowered pH, even when the larvae themselves were not directly exposed to the algae indicating a change in surface properties of the CCA as a result of these stressors. High-throughput sequencing of the CCA surfaces revealed significant shifts in the bacterial communities of CCA exposed to macroalgae. Given the increasing evidence that bacteria provide important settlement cues for some corals, it is likely that shifts seen in response of corals to surfaces treated with macroalgae and OA may be linked to changes in the bacterial communities on these surfaces.

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ADVANCING ENVIRONMENTAL MONITORING SOLUTIONS FOR OUR WORLD'S OCEANS (Abstract ID: 29565 | Poster ID: 548)

The Earth's changing climate provides many uncertainties. What we do know is the effect it is having on the oceans. Higher acidity levels are known to slow the growth of organisms forming calcareous skeletons or shells, including corals and shellfish. Ocean acidification investigation is an application that benefits from multi-parameter measurements expressed by the necessity of measuring at least two of the four parameters of the marine carbonate system. While analytical instruments are available for the four parameters, there is only one commercial option for measuring total alkalinity (TA) autonomously – the CONTROS HydroFIA® TA. Kongsberg Maritime CONTROS GmbH recently launched HydroFIA® TA, which is being used by researchers for continuous monitoring and the determination of the total alkalinity in seawater. In October 2015 a new project revolving around seawater alkalinity started: "Tracking Ocean Alkalinity using New Carbon Measurement Technologies." The project will use four different deployment platforms to enhance ocean acidification monitoring within the North western Atlantic extending from coastal hatcheries to the Iceland, and at a reef system in La Parguera, PR. Adding the all-new TA measurement capability (i.e. HydroFIA® TA) to the regional observation network is expected to provide more accurate and reliable ocean acidification monitoring. The outcome will provide much needed knowledge for ocean acidification studies that are important for examining the growth of organisms forming calcareous skeletons or shells, including corals.

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CORAL ASSOCIATED MICROBIAL PARTNERS INFLUENCE HOLOBIONT METABOLITE PROFILES (Abstract ID: 28760)

Microbial symbiotic partners, such as those associated with reef building corals, mediate biochemical transformations that influence host performance and alter the trajectory of individual survival. While evidence suggests microbial community composition partly accounts for differences in coral physiology, how these symbionts alter metabolic pathways remains underexplored. We aimed to assess functional variation between coral associated microbial partners in hospite. To this end, we collected fragments from 9 coral species and characterized associated Symbiodinium and prokaryotic communities in tandem with holobiont nuclear magnetic resonance based metabolomic profiling. Our data demonstrate Symbiodinium composition, prokaryotic communities, and metabolite profiles are species-specific. Taking this holistic approach in describing the relationships between metabolite composition and symbiont assemblages, we also show that a coral's symbiont composition significantly influences the colony's metabolite profile. Using Porites spp. as a case study, we present evidence that different sub-clades of Symbiodinium and prokaryote phylotypes distinctly influence the abundance and composition of functionally important metabolites. Our data suggests that while some microbial partners benefit the union, others are more opportunistic and possibly parasitize the host. Consequently, coral partner choice alters colony metabolite composition, likely influencing cellular metabolic activities and, therefore, colony nutritional provisioning.

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THE RISE OF SLIME IN SILURIAN CORAL-SPONGE-MICROBIAL REEFS IN ALASKA'S ALEXANDER TERRANE: INSIGHTS FROM ECOLOGICAL TRANSITIONS AFFECTING MODERN CORAL REEFS (Abstract ID: 28377 | Poster ID: 233)

The Alexander terrane (AT) is a Neoproterozoic island arc that accreted to North America in the Mesozoic. Diagnostic biotas constrain the AT's Silurian paleogeography to the N. Atlantic region, where the rising Caledonide Mountains induced enormous ecological changes in reefs that are analogous to those recorded at some modern reef sites. During the Silurian, the 3000 m-thick Heceta Limestone accumulated in the AT on top of a tropical, submarine volcanic edifice. Coral-sponge reefs grew at the edge of an expanding carbonate platform before they were decimated during mid-Silurian orogenic pulses. As carbonate sedimentation resumed, megalodont bivalves formed dense concentrates associated with peri-tidal microbial communities. At the platform margin, coral reefs were replaced by a distinctive microbial-sponge community, which built extensive stromatolite reefs in the absence of diverse metazoans. After experiencing regional extinction, AT reef biotas did not recover for several million years. The microbe-dominated reefs and nearshore stromatolites record widespread cyanobacterial "blooms" fueled by orogenic activity, which generated significant terrestrial influx, reduced habitats for normal-marine metazoans, and elevated nutrient loads. These ancient reefs indicate how the rise of microbial slime was related to a sediment glut, yielding insights into the devastation that modern coral reefs are likely to experience if human activities contribute increasing amounts of nutrient-laden sediment to the marine environment.

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FROM OTOLITH TO ORDINANCE: UTILIZING BIOLOGY AS BASIS FOR CLOSE SEASON POLICY FOR SIGANIDS (Abstract ID: 27933)

Translating scientific findings into policy is integral to successful resource management. Utilizing results of studies on the very small and unfamiliar part of fish known as otoliths or earbones, local policy action through passage of a town ordinance to declare close season for siganids has been achieved. The present study exemplifies a science-policy continuum for an extremely important resource, culturally and economically, in Lagonoy Gulf, northeast Philippines. Researches of Bicol University in the gulf revealed the ages at settlement of siganid juveniles (*Siganus spinus, S. canaliculatus, S. argenteus*) to be about three weeks based from analysis of the microstructure of the fish's otoliths. The highest volume of juvenile settlement occurred on and near the new moon dates in March, April and May. Adding few days for egg development of the fish, spawning has been inferred by back-calculation to occur between the first quarter and new moon. From these information, the researchers of the university sought audience and elucidated these results before the Tabaco City law-making council. After series of discussions with council executives and public hearing, the close season ordinance for siganids from February to May has been approved by the council in 2010. Under the ordinance, it is prohibited to catch juveniles, maturing and mature siganids during these months in the municipal waters. There has been very slight increase in juvenile production since 2010 in the last 5 years. Continuing challenge is monitoring compliance to the ordinance and its effectiveness.
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HIGH-LATITUDE REEFS AS NOVEL ECOSYSTEMS – MODELS FOR FUTURE SPECIES CONFIGURATIONS, INTERACTIONS AND FUNCTIONS (Abstract ID: 29111)

Ecosystems are responding to global change with novel species configurations, interactions and functions. Biogeographic transition zones, where tropical, subtropical and temperate species overlap, are ideal systems in which to study the links between novel species compositions, environmental gradients and ecological processes. Here, we examine these dynamics in the tropical-to-temperate transition zone in eastern Australia, where corals occur at their range limits. Systematic variation in zoogeographic, functional and phylogenetic patterns suggests that environmental filtering shapes coral biodiversity patterns. Corals on high-latitude reefs are a non-random subset of the Great Barrier Reef species pool, as only species that tolerate marginal conditions are able to persist. While this supports the dominant role of abiotic filtering at regional scale, phylogenetic diversity patterns reveal growing influence of competition at lower latitude. Range limit determinants of corals vary among taxa, as patterns in species richness and the abundance of tropical species respond to light availability, whereas cold stress and temperature variability limit subtropical species and functional diversity. Moreover, high abundance and gradients of macroalgae, echinoderms, other invertebrates and fishes point to the important role of these taxa in shaping ecological dynamics on high-latitude reefs. Gradients in the relative importance of different processes (e.g. competition, abiotic stress, herbivory) thus provide predictive models for potential novel reef configurations under climate change.
http://marinepalaeoecology.org/brigitte-sommer/

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MULTI-SCALAR INTERACTIONS OF A LOCAL ISLAND FISHERIES: SPATIAL MANAGEMENT AND GEOPOLITICAL CONSIDERATIONS (Abstract ID: 28453)

Fisheries and coral reef management is rarely contained in just one scale of governance. Shifts in international market conditions or new global agreements may affect how small-scale fisheries are managed and utilized. Similarly, fishers' strategies, through compliance and self-initiatives, can be expected to influence the governability of fishing regulations. While we know that management and conservation action is often connected to multiple scales, much research has been preoccupied with the local level, giving inadequate attention to the interactions that occur beyond the local processes. This presentation illustrates the multi-scalar nature of fisheries spatial planning and management by drawing on the Korean case of a Yeonpyeong Island fishery in the Yellow Sea. More specifically, by applying the notion of governmentality, I show that a locally-operating fisheries can be embroiled in domestic politics or international maritime boundary disputes, thereby being influenced by (as well as extending its influence to) wider governance scales. At the same time, this example highlights a case of fisheries embedded in extra-sectoral considerations (e.g., geopolitics), which are outside of the typical purview of resource conservation and management. I end the presentation by exploring what these insights might mean for coral reef conservation, with special reference to the circumstances unfolding in the South China Sea.

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DONGSHA ATOLL IN SOUTH CHINA SEA, THE STATUS, THE RESEARCH, THE STATION (Abstract ID: 28595 | Poster ID: 704)

Dongsha Atoll, situated in north South China Sea, is comprised of several major habitats. The 16 km-diameter lagoon and hundreds of patch reefs therein are mostly covered by hard corals. Extensive bleaching of stony corals occurred in summer of 2015. Most seemed to survive in according to a spotted survey in January 2016. The 80 km2 seagrass beds circles the lagoon and Dongsha Island;to large patches in north and northeast part of the atoll, totaling 25 km2, died off in summer of 2014 as recorded by satellite pictures and confirmed by ground truthing by divers. They have yet to recover and added another bleached patch in summer of 2015. The reef crest is covered by hard corals and debris. The reef slope extending down to 35 m deep and more is dominated by soft corals with hard corals playing a minor role; they remain unharmed in the 2014-present period. Since 2013, ~150 researcher-visits and ~1000 on-island-days exploited the facilities of Dongsha Atoll Research Station, per year. Accommodation, bench space, boats, as well as logistic support, etc were provided to both domestic and international researchers. The researches encompass issues related to global warming, ocean acidification, internal waves, reef geology, atmosphere, biology and biodiversity of tropical seas.

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CROWD-SOURCING CORAL REEF VISUALIZATION- THE ARRAS EXPERIENCE (Abstract ID: 30113 | Poster ID: 561)

The Automated Rapid Reef Assessment System (ARRAS) was a Philippine Government-funded research project which began in 2010 to develop low-cost tools and software to create permanent visual records of the sea floor at a fast rate. Four years on since we introduced an ARRAS platform so that coral reef visualization can be crowd-sourced (Teardrop ICRS 2012) we report our experience in deploying the tools as well as the feedback from local governments, schools, and regional environment and natural resources offices to whom the system was donated to. Their feedback led us to develop newer technologies such as towed platforms that can image shallow, wide or deep corals, software that can stitch high definition videos from multiple cameras, and calibration techniques to estimate coral sizes from video mosaics. Together with local partners all around the Philippines we have captured nearly 1000km of coastline around the archipelago, 1/10th of the estimated 10000km of coastline with reefs. The collected and processed data has been used for coral cover assessment, change detection, automatic classification studies and site selection.
http://arrasph.weebly.com

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SEXUAL REPRODUCTION IN THE CARIBBEAN CORAL GENUS ISOPHYLLIA (SCLERACTINIA: MUSSIDAE) IN PUERTO RICO (Abstract ID: 28476 | Poster ID: 178)

The sexual pattern, reproductive mode, and timing of reproduction of Isophyllia sinuosa and Isophyllia rigida, two small Caribbean Mussids, were assessed by histological analysis of specimens collected monthly during 2000-2001 and 2012. Tissue cores were fixed in Helly's Zenker formalin solution, decalcified in 10% HCl, dehydrated in 70% EtOH, embedded in Paraplast, sectioned with a rotary microtome, and stained utilizing a modified Heidenhain's Azocarmine-Aniline blue method. Results indicate that both species are simultaneous hermaphroditic brooders, with a single annual gametogenetic cycle. Spermatocytes and oocytes of different stages were found within the same mesentery indicating possible sequential maturation for extended planulation. Oocytes begin development in May in I. sinuosa and August in I. rigida, approximately 7 months prior to spermatocytes both sexes reaching maturity simultaneously over at least two months; May-June in I.rigida and March-April in I. sinuosa. Significantly higher polyp ($IR=33.16\pm4.44$, $IS=3.78\pm6.42$) (t-test, $p<0.001$) and mesenterial fecundity ($IR=2.76\pm4.44$, $IS=0.87\pm1.92$) (t-test, $p=0.046$) was found in I. rigida compared to I. sinuosa. Planulation proceeded rapidly in both species; planulae were observed in I. sinuosa during April through May and in I. rigida from June through September. Hermaphroditism and brooding have also been documented in the Mussid genera Scolymia and Mycetophyllia.

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MESOPHOTIC MACROALGAE ACROSS THE HAWAIIAN ARCHIPELAGO: DECIPHERING THE DIVERSITY AND DISTRIBUTION OF DEEP LIMU (Abstract ID: 29933)

Macroalgae are a conspicuous, yet poorly described, component of mesophotic ecosystems in Hawaii, forming habitat for coral reef fish in the Northwestern Hawaiian Islands (NWHI) and vast meadows in the Main Hawaiian Islands (MHI). Over the past 10 years, we have used submersibles, ROVs, and technical diving to survey the distribution and diversity of mesophotic algae at 76 sites across the Hawaiian Archipelago. Expansive macroalgal meadows of native or invasive green algae were found around Oahu (*Avrainvillea* sp., *Udotea* sp.) and the Maui Nui Island complex (*Halimeda kanaloana*) to 90 m, with distinct distribution patterns among specific islands. In contrast, macroalgal beds of *Microdictyon* were observed at mesophotic depths in the NWHI. Numerous new records and new species of macroalgae were discovered, suggesting the mesophotic flora is distinct from shallow water. Molecular analyses revealed that mesophotic sea lettuces in Hawaiian waters form unique communities composed of four new species within the genera *Ulva* and *Umbraulva*. Similar patterns of cryptic diversity are emerging for other dominant algae, such as the brown alga *Distromium*. Overall, the mesophotic flora appears to be abundant and biogeographically diverse with a combination of temperate, subtropical, and tropical affinities. The current study contributes greatly to our understanding of marine biodiversity and biogeography in the Pacific, and has significant implications regarding the unique nature of mesophotic coral ecosystems in Hawaii.

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MAUI'S CORAL REEFS; MANAGEMENT SUCCESSES AND FUTURE CHALLENGES (Abstract ID: 28469)

Maui's coral reefs are experiencing numerous anthropogenic stressors ranging from land-based sources of pollution to overfishing. Fifteen years of marine monitoring by the State of Hawaii, Division of Aquatic Resources, has highlighted examples where coral reefs appear to be degrading, as well as some instances of recovery. This information has been instrumental in guiding recent resource management efforts including changes to parrotfish and goatfish bag and size limits in 2014, and has helped evaluate past management actions including a ban on the use of lay-gillnets in 2007, and the establishment of the Kahekili Herbivore Fisheries Management Area in 2009. Here we review trends in both benthic cover and fish biomass to identify examples of resiliency in reef ecosystems, and to highlight management efforts that appear to have helped reefs recover from disturbances. Five years of herbivore management at Kahekili has resulted in biomass increases of 30% in surgeonfishes and 135% in parrotfishes, while the benthic cover of crustose coralline algae has increased from 2% to 14%. A crown of thorns outbreak in the Ahihi Kinau Natural Area Reserve resulted in a 78% reduction in coral cover, however ten years later, this reef has fully recovered. A careful evaluation of these types of reef recovery events will help managers prepare for and deal with newly emerging threats from global climate change and should help Hawaii's reefs survive into the future.

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SEXUAL REPRODUCTION IN THE CARIBBEAN CORAL GENUS*COLPOPHYLLIA* IN PUERTO RICO (Abstract ID: 29692 | Poster ID: 168)

Colpophyllia natans spawns during summer months throughout the Gulf of Mexico and Caribbean. Its reproductive cycle has never been characterized until a preliminary histological study in La Parguera, Puerto Rico in 1999, which revealed most gametes to be mature in spring, with few in summer. Therefore, indicating the presence of two reproductively isolated species. The second species seems to be the cryptic C. amaranthus. In this study our objective was to characterized the reproductive cycles of the two Colpophyllia species in La Parguera. After a morphological assessment in the field, two distinct morphologies were identified. Preliminary tissue samples were collected before summer spawning to confirm species identification by presence absence of mature oocytes. Then, tissue samples from five to ten colonies were collected monthly between July 2014 and June 2015. Samples were processed and examined following common histological protocols. Results of this study indicate both C. natans and C. amaranthus are hermaphroditic broadcasters with one annual gametogenetic cycle. Oogenesis lasted ten to eleven months and began earlier than spermatogenesis in both species. Furthermore, oocytes and spermatocytes developed in the same mesentery with gametes reaching maturation simultaneously. Spawning occurred in September for C. natans and March for C. amaranthus, with an average mesenterial fecundity of $7 \pm 5$ and $6 \pm 4$ respectively. These results are similar to other Caribbean Faviinae species. A taxonomic revision of the genus will be done in the near future with these data.

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INTERACTIONS OF CORAL RECRUITS AND JUVENILE CORALS WITH SEDIMENT AND ALGAE ON REEFS IN THE FLORIDA KEYS (Abstract ID: 30110 | Poster ID: 199)

Coral recruitment failure has been highlighted as a major factor contributing to coral reef decline. In the Florida Keys, past work has shown that there is a diverse and abundant supply of larvae, but this pattern is not reflected in the adult community. A possible explanation for this mismatch is that new recruits settle but are either smothered by sediment or outcompeted by neighboring organisms, particularly macroalgae. In the Florida Keys, reef rugosity (structural complexity) influences top-down control of macroalgae and accumulation of sediment. We hypothesized that the abundance of recruits and juvenile corals (<4cm) is related to rugosity, sedimentation, and macroalgal abundance. We surveyed coral reef communities at three high-rugosity and three low-rugosity sites in the Florida Keys to quantify the abundance of corals, turf and macroaglae, sponges, etc. We searched for recruits and juvenile corals, including in cryptic locations and under algae, and photographed each to analyze interactions with neighboring organisms. Juveniles and coral recruits were more abundant at the three high-rugosity sites, but had similar community size structure to the low-rugosity sites. Analysis of photos of individual recruits shows that and juvenile corals with more area in contact with macroalge tend to be smaller. Additionally, juvenile corals are less abundant in areas with high macroalgal cover.

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RE-VISITING THE ECOLOGY AND MORPHOLOGY OF RECENT CORAL REEFS (Abstract ID: 28415)

In 1969, David Stoddart published a major, 66 page review entitled 'Ecology and Morphology of Recent Coral Reefs' in the Biological Reviews of the Cambridge Philosophical Society. The review closed with a 14 point summary of current knowledge, concluding that 'central to any discussion of the relationships between ecology and morphology of coral reefs must be considerations of the time and space scales involved, of rates of adjustments and importance of lag effects within the system, and of boundary fluctuations.' In this paper, we re-visit Stoddart's tour de horizon and its over-arching theme, both in the general context of developments in coral reef science over the last half century and in terms of the specific contribution of David Stoddart himself to this debate.

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ASSESSING CORAL REEF HEALTH IN THE NORTH ARI ATOLL, MALDIVES USING THE FORAM INDEX. (Abstract ID: 28661)

Marine ecosystems in the Maldives are richly diverse, but are experiencing growing pressure from coastal development and tourism. Assessing the status of coral-reef communities along gradients of human pressure is necessary to evaluate recovery capacity of reefs in the face of anthropogenic threats. Islands in the North Ari Atoll, which are exposed to different human impact and management regimes (4 each community, uninhabited, and resort islands), were sampled during the International Union for Conservation of Nature (IUCN)-REGERATE Cruise in 2015. Assessments were carried out using the FORAM Index (FI), based on relative abundances of larger foraminiferal shells in reef sediments. Lower FI values in the vicinity of the community island of Rashdoo indicate likely nutrification of waters associated with disposal of domestic wastes. Somewhat higher FI values were recorded around the resort island of Velidhoo. The highest values were recorded near an unihabited island, Gaattafushi. Overall, FI values determined for the reefs in North Ari indicate that water quality should support active reef accretion by reef-building corals and larger benthic foraminifers. Note that the FI was designed to account for local changes in water-quality, and not for regional to global changes associated with temperature stress or ocean acidification. This study stems from a joint scientific expedition by IUCN-Marine Research Centre and University of Queensland to study coral reefs in North Ari. We warmly thank the Swiss National Science Foundation Projects 200021_149589 and IZK0Z2_165131.

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REEF SCENT: HOW BROODED CORAL LARVAE FROM A TOUGH CORAL SMELL THEIR WAY TO A NEW HOME (Abstract ID: 28255)

Coral reefs are highly diverse marine ecosystems of ecological, economic, and cultural value. With the expected negative effects on reefs from global climate change including rising sea temperatures and ocean acidification, the identification of resilient coral species has become increasingly important. *Leptastrea purpurea* is an encrusting coral that is found throughout the Indo-Pacific and Red Sea. While most corals are broadcast spawners, releasing sperm and eggs to be fertilized in the water column, some corals brood embryos within their tissues after internal fertilization. *L. purpurea* appears to release planula larvae on a continuous basis from the parent colony as observed during two years of monitoring. The planula larvae show remarkable resilience under a wide range of stressful conditions including temperature, sediment, and chemical stressors, as well as the ability to successfully settle and metamorphose after 180 days in controlled laboratory conditions. Various smells were tested to identify a settlement cue for *L. purpurea* larvae, and our results suggest that the smell associated with other coral colonies induce larval settlement and metamorphosis. Knowledge of the settlement cues and reproductive biology of this coral is important to our understanding of coral resilience in the face of anthropogenic perturbation.

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HABITAT AVAILABILITY AND DEPTH-DRIVEN POPULATION DEMOGRAPHICS REGULATE REGIONAL REPRODUCTIVE OUTPUT OF A COMMON CORAL REEF FISH (Abstract ID: 29645 | Poster ID: 189)

Coral reef organisms that span broad geographic and depth distributions experience a range of habitat quality, creating variable subpopulation demographics and dynamics. At the depth boundary of coral reefs, mesophotic coral ecosystems (30-150 m) that are buffered from anthropogenic stressors may be refuges that can seed larvae to degraded coral reefs. However, the degree of connectivity via larval production is restricted by population size and reproductive output of organisms at the periphery of their distributions. We incorporated population density, benthic habitat, and depth-stratified population demographics of a model reef fish (the damselfish *Stegastes partitus*) to assess subpopulation egg production across regions that encompass the depth distribution of the species: Florida Keys (FK: 0-35 m depths) and Pulley Ridge (PR: 60-100 m). Subpopulation densities and abundance peaked at mid-depths (10-20 m) and declined as depth increased. Egg production followed a similar pattern, but was considerably affected by differences in fish size, sex ratios, and probability and frequency of spawning across depths. Despite low population densities on mesophotic reefs, the expansive reef area at PR resulted in a subpopulation size that comprised 20% of the regional population and 14% of the total reproductive output across the study region. Our results indicate that mesophotic reefs may be important sources of larvae, and that habitat availability and depth-driven population demographics have substantial effects on reproductive output across geographic regions and depths.

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ASSESSING FACTORS AFFECTING CORAL TRANSPLANTATION SUCCESS IN INNER APRA HARBOR, GUAM (Abstract ID: 27968 | Poster ID: 485)

Early results from an on-going coral transplantation experiment in Inner Apra Harbor, Guam will be discussed. Study objectives include: can corals be successfully relocated from a wharf face to an adjacent site; do the corals maintain good health and grow after relocation; and what key factors affect relocation success? In July 2015, 96 healthy coral colonies from 4 species were removed from the face of X-Ray Wharf in Inner Apra Harbor and reattached to locally sourced limestone boulders placed at comparable water depths approximately 450 m away. Corals were detached and transported under water, and attached using Portland cement. The experiment includes six replicates of 16 boulders each, with one coral attached per boulder. Reference colonies of the 4 species were selected adjacent to the relocation site. Effects of species, colony size, and orientation on survivorship will be monitored for 24 mos. Survival, tissue growth, attachment, colony health, predation, disease, algae overgrowth, and paling/bleaching will be assessed. Observations from the first 2 monitoring events indicate all relocated corals firmly attached to the substrate. Most of the relocated corals and half of the reference corals showed one or more stress conditions such as paling and tissue loss. Heavy rainfall during September/October 2015 resulted in increased sediment suspension and runoff into the harbor. Water temperatures were also slightly higher during 2015. The increased sedimentation along with elevated temperatures may have contributed to the stress conditions exhibited by the relocated corals.

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A CONCEPTUAL MODEL OF OYSTER REMEDIATION FOR CORAL REEF RESTORATION IN BARBADOS (Abstract ID: 28982 | Poster ID: 462)

The viability of using bioremediation to enhance coral reef recovery in Holetown Bay, Barbados was assessed to develop a conceptual model for bioremediation, taking into account the current and historic water quality data from water column and pore water. The study investigated similar bioremediation in temperate locations, and proposes using similar oyster-facilitated water quality improvements to catalyze coral reef restoration in Barbados' degraded reefs. Different methods of oyster culture were considered, exploring the extent to which oyster culture traditionally done using the Eastern oyster (Crassostrea virginica) could be adapted to boost the population of indigenous mangrove oysters (C. gasar). Breakwaters in Holetown are highly suitable for oyster growth, and oyster settlement is apparent. However, oysters are harvested and unable to improve water quality to a level that would enhance coral regrowth. The model determines how many spat would be needed to create enough oyster settlement to sufficiently filter nutrients and particulates in order to promote coral growth, and proposes public education and surveillance to ensure oysters remain to perform their bioremediation function. Estimated costs for seeding the Bay and monitoring oyster settlement and water quality are shown to be relatively small, especially compared to the economic gains that could be made by improving water quality and promoting reef-based marine tourism. This study represents the first known conceptual model for using oysters to enhance water quality and promote coral reef restoration.

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TRY WAIT! REVIVING THE PRACTICE OF KAPU TO REPLENISH MARINE LIFE AT KA'ŪPŪLEHU, HAWAI'I (Abstract ID: 29990)

Today, the practice of managing fisheries by abstaining from harvest has become controversial in Hawai'i, though it has not always been so. The traditional Hawaiian concept of natural resource management ensured a mutually beneficial balance between people and ecosystems – in part through a comprehensive system of rules (kanawai) and prohibitions (kapu) that governed interactions with people and nature. As traditional Hawaiian management practices, include the ability to strictly regulate harvest of wild-caught marine species, were replaced by new laws in the 20th Century, some areas of Hawai'i were insulated from sweeping social change by virtue of their relative isolation and maintenance of an uninterrupted connection to both land and ancestral knowledge. Termed cultural kipuka, and likened to hills with high native biodiversity surrounded by more recent lava flows, these areas maintained connections that were lost elsewhere. By utilizing scientific data from Kenya, the Philippines, Palau, and across the Main Hawaiian Islands, a compromise to rest a coral reef from fishing for 10 years to grow fish while a sustainable harvest plan is developed represents a blend of traditional and modern fishery management. . Learn more about Ka'ūpūlehu and how local knowledge and global science informed this approach that honors the culture of Hawai'i and benefits the resources upon which we all depend.

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PHYLOGENETIC ANALYSIS OF NUTRIENT TRANSPORTERS IN THE CNIDARIAN-DINOFLAGELLATE SYMBIOSIS (Abstract ID: 28861)

The nutritional exchange between host and symbiont plays a critical role in maintaining the cnidarian-dinoflagellate symbiosis. Using a bioinformatics approach, we investigated the nutrient uptake mechanisms of each partner to discover membrane proteins involved in transporting sugars into cnidarian cells and nitrogen products into *Symbiodinium* cells. Five protein groups were investigated: the facilitated glucose transporters (GLUT), the sodium/glucose cotransporters (SGLT), the aquaporin channels (AQP), the ammonium transporters (AMT), and the high-affinity nitrate transporters (NRT2). Homology searches were conducted to identify cnidarian sugar transporters (GLUT, SGLT, and AQP) closely related to well-characterized proteins from other metazoans, and to identify dinoflagellate (*Symbiodinium* spp.) ammonium and nitrate transporters (AMT and NRT2) closely related to well-characterized proteins from other alveolates and plants. Protein phylogenies were constructed to estimate the evolutionary placement of newly identified cnidarian proteins among other metazoans and newly identified *Symbiodinium* proteins among other alveolates, as well as to infer characteristics from closely related homologs. Ultimately, multiple cnidarian homologs were discovered in all sugar transporter groups, as well as multiple *Symbiodinium* homologs in the ammonium and nitrate transporter groups. We present the corresponding protein phylogenies and discuss the possible role of these proteins in nutritional exchange between symbiotic partners.

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RELATIONSHIPS BETWEEN FISH COMMUNITIES AND HABITAT COMPLEXITY ON CORAL REEFS IN MALAYSIA (Abstract ID: 29223)

Habitat structure is known to determine the abundance and diversity of coral reef fish communities. Areas with greater habitat complexity generally support higher numbers of fish species. We examined reef fish community structure and the influence of coral cover and habitat complexity at 3 locations on the east coast of Peninsula Malaysia: Redang, Tenggol and Tioman Islands, all in marine protected areas. There is a lack of ecological research on coral reefs in this region, which is just outside the Coral Triangle. Underwater visual surveys of reef fishes and benthic habitats were conducted to examine large and local scale variation in fish abundances and community structure, and one-minute timed swims were filmed in different habitat types to examine the effects of habitat structure on reef fish species richness at a finer spatial scale. The reef fish communities were similar among the 3 locations, however there were some differences in relative abundances of the most common species. Densities of coral-associated species correlated positively with coral cover. The timed swims on different habitat types showed that many of the fish species, particularly the damselfishes, have strong associations with particular coral morphologies or particular types of dead or non-coral substrates. For both of the most abundant and speciose fish families, the damselfishes and wrasses, species richness was higher in areas with a mixture of habitat types compared to areas with almost 100% cover of either live coral or dead/non-coral substrate. This work adds to our understanding of the importance of live coral diversity and spatial heterogeneity in structuring reef fish communities.

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QUESTIONS WE NEED TO ASK! (Abstract ID: 27866)

Science and scientists develop along two distinct avenues; by either following a trend and studying what others study, or by exploring novel questions often enabled by technological advances that open new frontiers. Common to both is a level of secrecy about

what is being done, how, and by whom, a scenario that leads to significant redundant effort within the reef science community. Further, reef scientists almost never openly discuss the importance or relevance of questions being explored before the work is started, or while it is in process, and individuals working on closely related questions generally compete rather than coordinate, even though the latter would result in the greatest knowledge gain. This session focuses on basic questions and collaboration. We will explore long-standing unanswered and new questions that, if answered, could rapidly advance our understanding of corals and corals reefs. In short format talks, presenters will be asked to present unanswered questions, highlight their importance, discuss perceived obstacles, and suggest ways to potentially overcome these and advance the science in their specific area. The session will be highly interactive and the presentations used to stimulate a dynamic discussion regarding the themes raised as well as other activities and questions of importance in coral reef science. The goal is to develop a community-prioritized list of research activities and collaborations that can serve as a guide for future work and a framework for funding agencies in their calls for research

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SEASCAPE MODELS REVEAL THE EFFECTS OF FISHING PRESSURE ON HABITAT USAGE OF CORAL REEF FISHES (Abstract ID: 29237)

The influence of habitat has long been understood to play a primary role in structuring fish assemblages and driving their distributions. Interactions between multiple variables across scales determine habitat suitability and quality for individuals and species. In addition to physical variables such as wave energy, a major factor structuring fish assemblages is the impact of fishing. Biomass of targeted reef fishes under low, medium, and high fishing pressure in the main Hawaiian Islands was modeled based on a suite of remotely sensed habitat variables, including structural and spatial pattern metrics, in a seascape ecology approach. A fishing pressure index based on accessibility to humans and scaled by total fishing effort by island was used to stratify reef fish survey locations. Boosted regression trees revealed that even very low fishing effort (<5 trips/ha) had implications for resource fish biomass. For all target fish combined, structural complexity emerged as the key predictor across all fishing pressure categories. Small-bodied fishery species were associated primarily with structural complexity at low levels of fishing, suggesting the influence of predation, while the distribution of large-bodied species was driven largely by wave power, which may reduce fishing pressure and mitigate land-based pollution. This novel approach reveals how human influence affects the relationship of reef fishes to their environment and has important implications for ecosystem-based management of nearshore fisheries in Hawaii.

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HOW MARKETS ARE INFLUENCING GOVERNABILITY OF SMALL SCALE FISHERIES: UNDERSTANDING OPPORTUNITIES FOR MULTI-SCALE GOVERNANCE (Abstract ID: 28206)

Market systems are increasingly influencing small-scale fisheries. On one hand market interactions are considered key for economic development and poverty alleviation. On the other hand, price fluctuations, high market demand and monopolies have shown to compromise food security of the marginalized poor and threaten ecological sustainability. Small scale fisheries are complex and involve various governing institutions operating at different levels with different objectives. Multi-scale fishery market chains connect fishers, traders, managers and consumers. Considering this we question the simplistic dichotomy that commonly frames market as an influence on fisheries. We propose that closer consideration of how multiple governance systems emerge and function along a market chain yields more nuanced understanding of how governance of a small-scale fishery at the chain's supply-side is influenced. Five small-scale fisheries with varying local to global market chain lengths operating in the Coral Triangle Region are examined. Drawing from Interactive Governance theory we identify governing systems that have emerged at particular points in each market chain, and which are formed from specific arrangements of 'governance subsystems'. We recognize four governance subsystems that appear dominant in contemporary fisheries management; namely those centered on (i) government, (ii) decentralized multi-stakeholder management, (iii) private sector and pricing, and (iv) culture and social relations. This perspective highlights opportunities towards more effective multi-scale governance.

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ULTRAVIOLET RADIATION AND CORAL EMBRYOS: DNA DAMAGE, SURVIVAL, AND DEVELOPMENT (Abstract ID: 29715 | Poster ID: 46)

Embryos of broadcast spawning reef corals spend 2-3 days floating near the ocean surface as they develop into mobile, ciliated planula larvae. These embryos may be exposed to high levels of ultraviolet radiation (UVR), particularly UVB (280-320 nm) that stimulates production of thymine dimers in DNA and interferes with replication and transcription, potentially increasing mortality or developmental defects or altering timing of development. In an effort to quantify the impact of UVR exposure on coral embryos and identify mechanisms that have evolved to mitigate negative effects, we measured UVR-induced DNA damage, survival, and development in the embryos of a Caribbean coral, Acropora palmata. Embryos were reared in outdoor tanks shaded by either UVR-transparent or UVR-opaque plastic. Samples for DNA damage and development were collected and survival assessed each afternoon after peak UVR exposure. DNA damage was quantified in coral embryos with an ELISA assay using a primary antibody that binds to thymine dimers, while the development time series was assessed via microscopy. We found that, over time, differential UVR exposure had little effect on DNA damage, timing of development, or survival in A. palmata embryos. Early differences in DNA damage and development timing between UVR exposure treatments disappeared by the third day after fertilization. Our findings on embryos support previous data from larval and adult life stages that A. palmata is well adapted to deal with the high UVR stress that accompanies life in shallow, clear tropical waters.

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RESPONSE OF EARLY CORAL SETTLERS TO ENVIRONMENTAL CONDITION IN PELEKANE BAY, HAWAI'I (Abstract ID: 30105 | Poster ID: 454)

Larval production, early settlement and recruitment of corals are crucial biological processes for preservation of coral reef ecosystems. While coral settlement and recruitment has been known to show high natural variability in a given time and space in Hawai'i, early settlers and recruits may be especially sensitive to environmental degradation and unsuitable habitats. The distribution of coral settlement were studied in the Pelekane Bay and Kawaihae area, West Hawai'i to better understand the spatial and temporal variability of Hawaiian coral settlers, their response to human-altered environmental conditions, and to provide a baseline for long-term monitoring information that is essential to the effectiveness of corrective management effort in the South Kohala region. Settlement arrays were deployed at 37 sites along an environmental gradient established in 2010 and 2011, and replicated in 2014. On average, coral settlement is extremely low in the highly-sedimented inshore environment compared to farther offshore . There is no large statistical variation between years. Although overall variability of coral settlement has been known to be typically high in time and space, there was a considerable difference between the abundance and distribution of settlers by environmental conditions and habitat characteristics. Patterns of coral recruitment can be a useful indicator of environmental change and the potential recovery in relation to land-derived sedimentation in Hawai'i.

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THE EASTERN CARIBBEAN: A LABORATORY FOR STUDYING THE RESILIENCE AND MANAGEMENT OF CORAL REEFS (Abstract ID: 28490)

"Degradation" is almost synonymous with the phrase "Caribbean coral reefs". The most commonly cited causes of decline are global warming, ocean acidification, pollution and overfishing. However, determining the relative contribution of these stressors is difficult because often all occur simultaneously. We assessed reef condition over a 736 km region of the eastern Caribbean from Anguilla to Grenada focusing on (when possible) the windward shores of low islands with little or no runoff. Islands of this archipelago are oceanographically and biologically distinct from adjacent islands due to the strong Equatorial Current and Trade Winds. We focused on coral reefs with no-take reserves (NTR) and high compliance (based on interviews and observations) compared to adjacent control reefs. We studied 55 reefs among 15 islands with 642 fish transects (n = 36,905 fish), and 217 coral/algal transects. Overall, NTR had twice the fish and parrotfish biomass, significantly less macroalgae and significantly greater abundance of adult and

juvenile corals than the adjacent fished areas. Coral cover in some reserves averaged over 35% (twice the abundance of fished reefs). In St. Croix where we documented a 30% decline in coral cover from 1982 to 1995, revisiting the same sites in 2014 revealed live coral at nearly 1982 level with expansive stands of Acropora palmata in places. We conclude that local management of reef fish and particularly herbivorous fish can have a strong positive impact on coral reefs thereby facilitating their recovery and improving resilience to a healthy state.

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THE SMARTFIN: HOW SURFING COULD HELP INFORM COASTAL OCEAN SCIENCE AND CONSERVATION (Abstract ID: 30020 | Poster ID: 722)

Coastal marine ecosystems only represent a small percentage of the global ocean's surface area. However, these ecosystems are highly productive, rich in biodiversity, and are where the vast majority of human activity occurs. The complex interaction between seawater, land, and atmosphere makes coastal ecosystems some of the most dynamic in terms of seawater chemistry. In order to capture these dynamic changes in seawater chemistry across appropriate spatial and temporal scales requires a large amount of measurements. Unfortunately, it is often challenging to maintain an array of oceanographic sensors in coastal ecosystems, especially in high energy areas like the surf zone. Citizen science has the potential to increase the collection of oceanographic data from coastal systems such as coral reefs where traditional methods are more difficult or expensive to implement. This talk will highlight the Smartfin, a surfboard mounted fin that measures seawater chemical parameters, physical wave characteristics, and GPS location during an ordinary surf session. Coral reefs offer some of the most attractive and crowded surf breaks, and with an estimated 23 million surfers worldwide the Smartfin could greatly enhance vital data collection at these sites. The data from a Smartfin can be immediately uploaded to a server via Bluetooth and WiFi connection, making the data available in real time. Real time information on variables such as surface seawater temperature could help to better inform coral reef scientists, conservationists, and managers.

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SEDIMENT TRAPS FOR MONITORING LAND-BASED IMPACTS ON MARINE ECOSYSTEMS: APPLICATIONS AND RESULTS IN AUSTRALIA AND CORAL TRIANGLE INITIATIVE REGION (Abstract ID: 29900 | Poster ID: 458)

Increasing interest in land-based impacts on marine ecosystems makes it necessary to monitor impacts with appropriate technology. Sediment traps are a simple but effective technology to provide tangible time-integrated samples. Much of the research on sediment traps to date relates to efficiency of instruments to collect suspended particles. However, there is limited understanding of the precision of instruments under natural environmental conditions or subsequent inference space of trap results over a range of spatial and temporal scales. Our recent studies show that well designed sediment traps have excellent precision, and that large differences in the composition and concentration of suspended sediment can occur over fine scales in what appear to be relatively homogeneous coral reef environments. We describe a methodology that may be useful for assessing the precision of sediment traps and further assist in the calculation of trap efficiency. Examples from the application of Sedisampler(TM) traps, including sampling design and initial results will be discussed from several long-term monitoring projects, including in the Coral Triangle (Kimbe Bay, Papua New Guinea), and Australia (Great Barrier Reef and Shark Bay). Our results suggest that monitoring of suspended sediment at coral reefs requires methods that can capture spatial and temporal variation at finer scales than is typically possible at present. Sediment traps are underutilized for investigating the role and fate of suspended particulate matter, and associated contaminates, in marine ecosystems.

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ARE YOU MY BROTHER? RAD GENERATED SNPS REVEAL HIGHLY CONNECTED PARROTFISH POPULATIONS WITHIN THE PHILIPPINES. (Abstract ID: 28843)

Coral reefs within the Coral Triangle are home to the greatest marine diversity on the globe, but are often subjected to extreme fishing pressure. Marine protected areas (MPAs) have been proven to be effective management tools in this region, however the ability of MPAs to promote connectivity and resilience across large distances is still poorly understood. We used RADseq to discover 4,235 and 12,619 SNPs for two species of parrotfish (*Scarus niger* and *Chlorurus bleekeri*) and 16,853 SNPs a rabbitfish (*Siganus guttatus*) collected in the Philippines and Vietnam. Population analyses suggested high levels of gene flow within the Philippines (pairwise FST ranging from 0.0007 to 0.0018), weak structure between Vietnam and the Philippines (pairwise $F_{ST}$ between 0.021 and 0.025). Additionally, sibling analyses revealed 1 pair (*S. niger*) and 4 pairs (*C. bleekeri*) of putative full siblings (r = 0.773 – 0.500) and 1 pair (*S. niger*) and 6 pairs (*C. bleekeri*) of putative half siblings (r = 0.499 - 0.191) for sites separated by more than 400km. The low $F_{ST}$ values and sibling pairs across distant reefs indicate both genetic and demographic connectivity. These patterns suggest that MPAs within the central Philippines could theoretically provide an influx of larvae to overfished reefs throughout the region.

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TEMPORAL VARIATIONS IN CALCIUM CARBONATE DISSOLUTION RATES UNDER AMBIENT AND ELEVATED PCO2 IN A SHALLOW CORAL REEF LAGOON (Abstract ID: 28219)

Dissolution of permeable calcium carbonate ($CaCO_3$) sand on coral reefs is likely driven by environmental dissolution (overlying bulk seawater chemistry), benthic metabolism, and bioerosion. Most studies on dissolution are confined to laboratory, mesocosm, or rare in situ studies, but none of these have considered seasonal variations. Coral reefs exhibit high natural variability of carbonate chemistry on spatial and temporal scales, driven by processes such as photosynthesis, respiration, calcification and $CaCO_3$ dissolution. This inherent variability of reef biogeochemistry complicates projections for the effects of ongoing ocean acidification on coral reef ecosystems. In order to understand future responses of coral reef ecosystems to elevated carbon dioxide ($CO_2$) it is necessary to first understand the natural variability of the carbonate chemistry and dissolution rates and the controls on these processes. This is particularly important in the context of a possible shift from net calcification to net dissolution of reefs which some models project for the end of the century. This study investigated $CaCO_3$ dissolution rates under both ambient and elevated $CO_2$ levels in relation to seasonal variations in water column physico-chemical properties and benthic metabolism.

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CORAL REEFS AS CHAOS: AN ASSUMPTION-FREE, SYSTEM-STATE APPROACH TO CAUSALITY, DYNAMICS AND PREDICTIONS (Abstract ID: 30026)

Although there is a high risk of continued reef loss on a global scale, responses to widespread stressors at local and regional scales indicate that resilience to chronic stress is possible but also variable. Coral reefs are complex systems that exhibit nonlinear behavior, including chaos, feedbacks, multistabilities, cascading effects, adaptation and emergent phenomena. Using traditional models to resolve these dynamical processes that control resilience is problematic due to error from excluded variables, incorrectly identifying mirage correlations as system drivers, and untestable assumptions about relationships between variables. Alternatively, a changing coral reef can be considered a trajectory through different states, whose change over time depends on previous states and is determined by a set of rules. We present a promising new technique for understanding and forecasting ecosystems that is adapted from single-species Empirical Dynamic Modeling, using time series data to reconstruct nonlinear state-space. This reconstruction preserves the topology of its chaotic attractor manifold, which represents a trajectory of linked variables through state-space, allowing us to correctly discern shared causal drivers from interactions. Without the need for error-inducing model assumptions, this approach also outperforms all other tested models for forecasting system dynamics. We show ecosystem-scale predictions from simulated and real data that demonstrate the tremendous value of this tool for improving our understanding and management of coral reefs in a changing world.

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MODELING CORAL LARVAL DISPERSAL AND INTERISLAND CONNECTIVITY TO HELP DESIGN MUTUALLY-SUPPORTING MARINE PROTECTED AREAS: INSIGHTS FROM MAUI NUI, HAWAII (Abstract ID: 28753)

Connectivity is one of the most important factors in evaluating the size, number, and spacing of individual marine protected areas to design an integrated network of marine protected areas. To provide such information for federal, state, and local managers in Hawaii, the US Geological Survey, Deltares, and the University of Hawaii worked to develop a physics-based numerical circulation model to determine the role of ocean currents in transporting coral larvae from natal reefs in Hawaii's Maui Nui complex

(Maui, Lanai, Molokai, and Kahoolawe). Spatially- and temporally-varying WRF-ARW wind, WAVEWATCH III wave, and NCOM circulation model output were used to drive a three-dimensional, physics-based Delft3D circulation model for the Maui Nui complex. The model was calibrated and validated using surface current drifters deployed during the July 2013 coral-spawning event. The Delft3D model was then used to simulate the movement of reef-building coral Montipora capitata larvae from 17 reefs during 5 spawning events in 2010-2012. These simulations allow us to investigate not only the general dispersal patterns from individual coral reefs, but also how anomalous conditions during individual spawning events can result in large deviations from those general patterns. Overall, the data suggest that many of the coral reefs in Maui Nui seed reefs on adjacent islands, demonstrating the interconnected nature of the coral reefs in Maui Nui and providing the scientific underpinning for the design of a mutually-supporting network of marine protected areas to support coral reef conservation.
http://coralreefs.wr.usgs.gov/

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RNA-SEQ AND MANIPULATIVE EXPERIMENTS IDENTIFY KEY RECEPTORS INVOLVED IN LARVAL COMPETENCY (Abstract ID: 29809 | Poster ID: 194)

Dispersal potential of a species is a major parameter used in reef-conservation management and is also a key target for evolution in response to climate change. The length of the larval competence period greatly contributes to a larva's ability to disperse to new environments. Identifying key receptors and groups of genes underlying larval settlement competency would provide insight into mechanisms underlying the ability of corals to disperse. We measured settlement competency, global gene expression and larval fluorescence throughout thirteen days post-fertilization in *Acropora millepora*. Molecular changes that strongly correlated with competency and fluorescence included upregulation of ion channels, calcium-binding proteins, and G-protein coupled receptors. A drug screen targeting these receptors confirmed that they are involved in driving larval settlement behavior and metamorphosis. This study also gives insight into the possible biological function of coral fluorescent proteins through this important life-history stage.

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PHYSIOLOGICAL RESPONSES OF ACROPORA TENUIS ON A NUTRIENT AND TURBIDITY GRADIENT IN THE GREAT BARRIER REEF (Abstract ID: 29584)

Rising seawater temperatures from increasing atmospheric greenhouse gas concentrations increase rainfall variability in many tropical regions. This leads to increased terrestrial runoff and more frequent flood events, which washes sediments and nutrients from urbanized river catchments into coastal waters and increases turbidity level in inshore coral reef ecosystems. To date it remains controversial whether coastal eutrophication increases resistance / resilience of scleractinian corals to predicted environmental changes (e.g. increasing seawater temperature, cyclones, UV radiation), or if corals in nutrient-enriched or turbid waters are more vulnerable to those stressors. To assess coral health on a nutrient and turbidity gradient, the physiological performance of the branching coral Acropora tenuis was investigated at three inshore reefs (Burdekin River catchment region) of the Great Barrier Reef and in two mid-shelf reefs, which are distant from most terrestrial influences. Net photosynthesis, dark respiration and calcification rates of live corals were determined in field based light and dark incubation experiments. Coral samples were further analysed for total antioxidant capacity and programmed cell death as marker for cell protection and tissue maintenance. Acropora tenuis showed strong physiological performance and a high level of cell protection at all reefs investigated. Nevertheless, net photosynthesis and calcification decreased with reduced light intensity, which suggests reduced skeletal density and lower resilience of corals at more turbid inshore reefs.

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POTENTIAL CHANGES IN THE DISTRIBUTION OF EASTERN PACIFIC REEF CORALS IN RESPONSE TO CLIMATE CHANGE (Abstract ID: 28179 | Poster ID: 366)

Climate change will modify oceanographic conditions and probably leave only limited areas with suitable conditions for reef development; one of these may be the Eastern Tropical Pacific (ETP) one of the most outlying and geographically isolated reef regions in the world. The objective of this work is to evaluate potential range shifts in 27 reef-corals currently resident in the ETP, on the basis of ecological niche models (built with the MaxEnt software) and prognostications of temperature increase from an ensamble of six different global models and under the RCP 2.6, 4.5 emission scenarios for the year 2050 and RCP 8.5 for the years 2050 and 2100. The basic data correspond to georeferenced occurrence records of the species, combined with 27 oceanographic variables. Results show that the overall average loss of habitat of the reef corals in the ETP would reach respectively 52%, 47% and 29% in scenarios 2.6, 4.5 and 8.5 in 2050 and 54% in the scenario 8.5 in 2100. In scenarios 2.6, 4.5 and 8.5, 2050, respectively, thirteen, thirteen and four species lose more than 50% of their distribution area and one its entire area. In the scenario 8.5 in 2100, fourteen species lose more than 50% and one suffer local extinction. On the other hand, between the species that would increase their geographic area, only few of them would extend their ranges to higher latitudes. Evaluating the individual contribution of environmental variables on the MaxEnt models, light attenuation was key to determine distribution in most species, and might be the factor that would limit latitudinal displacement of populations to the north in response to ocean warming.

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UNDERSTANDING THE IMPACTS OF DREDGING ON SPONGES (Abstract ID: 29035 | Poster ID: 435)

Dredging operations generate three central abiotic stressors for marine organisms. Elevated total suspended solids (TSS) can cause light attenuation and result in high sediment deposition. These stressors can impact ecologically important filter feeders, including sponges. Experimental exposures using six abundant and broadly distributed sponge species revealed that stress responses were species specific. Whilst *Carteriospongia foliascens* exhibited high mortality under both elevated TSS and low light, most species exhibited sublethal responses to the three stressors. Novel sensitive methodologies were developed to characterise and quantify these sublethal stress responses. Microcomputed tomography (microCT) scanning was used to visualise and quantify sediment management strategies in 3D and revealed that *Stylissa flabelliformis* employs both active and passive mechanisms for moving sediment within sponge tissue. Customised thermistor flowmeters were additionally constructed to measure changes in sponge pumping rates. Short term exposure of *Cliona orientalis* to high TSS decreased pumping rates within one hour with complete pumping cessation after 2 hours. This research provides an improved understanding of sponge responses to dredge-related pressures and will contribute to more effective management of dredging operations in the future.

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FUNCTIONAL DISTINCTIONS AMONG BROWSING HERBIVOROUS FISHES: REDUCED REDUNDANCY AND THE IMPORTANCE OF LARGE INDIVIDUALS (Abstract ID: 28466)

By identifying functional groups among coral reef fishes we can begin to understand key drivers of reef resilience. However, broad classifications of species into functionally homogenous groups may disguise important variety. In browsing herbivorous fishes, numerous studies have identified the species feeding on mature macroalgae, and how this varies spatially, temporally, and among different algal types. Remarkably bites per se have received little attention beyond being counted, although they form the essence of the herbivorous function. We quantified details of the feeding-behaviour and -morphology of the four dominant browsing species on the Great Barrier Reef. The algal material they targeted revealed two distinct groups: 'entire thallus-biters' vs. 'leaf-biters'. *Kyphosus vaigiensis* and *Naso unicornis* indiscriminately bit on the entire macroalgal thallus in 90% of bites. In contrast, *Siganus canaliculatus* and *S. doliatus* targeted leaves only, selectively avoiding stalks. Across species, differences in body size supported this functional distinction. As the smaller 'leaf-biting' species are unlikely able to compensate for a loss of the functionally dominant larger 'entire thallus-biting' species, functional redundancy within the macroalgal browsers appears not only lower than previously assumed, but also at risk through exploitation of large fishes. These findings caution against assumed homogeneity within this, and potentially other, functional groups on coral reefs, and highlight the importance of evaluating behavioural details.

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NEW VIIRS SATELLITE OCEAN COLOR PRODUCTS FOR MANAGEMENT OF LAND-BASED SOURCES OF POLLUTION OVER CORAL REEFS (Abstract ID: 28389 | Poster ID: 444)

The National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Watch (CRW) program has teamed with NOAA's Center for Satellite Applications and Research (STAR) Ocean Color Team to develop new satellite products designed to assist managers in monitoring the threat of land-based sources of pollution (LBSP) to coral reef ecosystems. Areas of focus include U.S. Coral Reef Task Force Priority Watershed sites and related reef areas in Puerto Rico, Hawai'i, and American Samoa. Near-real-time satellite products of turbidity (Diffuse Attenuation Coefficient at 490nm- Kd[490]), Chlorophyll-a, and sea surface temperature (SST) are being developed using ~750m resolution ocean color measurements from the Visible Infrared Imaging Radiometer Suite (VIIRS) launched in 2011. Background levels of each parameter are being derived using historical VIIRS data from 2012 to the present. Anomaly and time-series products are being constructed to give managers information as to how water quality conditions have varied through time. In collaboration with NOAA's Educational Partnership Program (EPP) and local student interns, in-situ measurements will be taken over coral reefs to validate each parameter. A pilot calibration/validation field study of the VIIRS ocean color products for coral reefs is already underway in the Guánica Bay Watershed, La Parguera, Puerto Rico with the University of Puerto Rico. Building on this pilot effort's success, the project will expand to include Hawaii's priority West Maui watersheds in 2016 and hopefully American Samoa in 2017.
http://coralreefwatch.noaa.gov/satellite/research/oceancolor.php

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COMPARING GENETIC CONNECTIVITY AND GENE EXPRESSION ACROSS SHALLOW AND MESOPHOTIC REEF CORALS IN THE GULF OF MEXICO (Abstract ID: 28954)

Mesophotic coral ecosystems (MCEs) comprise reef environments between 30-150m and in some cases have coral communities similar to those found on shallow reefs. Glynn (1996) originally proposed that deeper reefs may act as a coral refuge by providing larvae to nearby shallow reefs. Key questions underlying this theory remain unanswered including: (1) How well are MCEs connected to shallow reefs, and (2) Can corals adapt their morphology and gene expression to match changing environmental stimuli? To address these questions, an integrative approach combining assessments of genetic connectivity, gene expression, and corallite morphometrics was employed to investigate *Montastraea cavernosa*, a ubiquitous depth-generalist species in the Flower Garden Banks National Marine Sanctuary (FGBNMS) and Pulley Ridge MCEs. Microsatellite analysis suggests panmixia between FGBNMS banks and relatively high connectivity across sites in the Caribbean and SW Florida, consistent with dominant current patterns in the Gulf of Mexico. Genetic differentiation in the Pulley Ridge population indicates relative isolation of *M. cavernosa* from other sites in the Gulf. Gene expression profiling was completed using a novel RNA-Seq pipeline, resolving whole-transcriptome differences among shallow and mesophotic corals at FGBNMS. This research is designed to provide data for improved regional management of deeper coral reef ecosystems and collaborative marine research with NOAA partners through the Cooperative Institute for Ocean Exploration, Research, and Technology.

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APPLICATION OF MASS SPECTROMETRY-BASED PROTEOMICS TO STUDY LARGER BENTHIC FORAMINIFERA AND THEIR RESPONSES TO ENVIRONMENTAL CHANGES (Abstract ID: 28735)

A new method for studying large benthic foraminifera (LBF) using novel proteomic techniques was developed. Foraminifera are a highly diverse group, contributing strongly to calcium carbonate production within oceans and commonly used as environmental indicators. LBF harbor photo-symbionts making them vulnerable to environmental changes, especially ocean warming. Due to their small size, genetic and traditional protein studies are challenging. Even for the cosmopolitan group Amphisteginidae, very little is known about their molecular biology. Therefore, cellular processes occurring in response to environmental changes are widely unknown. The presented method is based on the complete proteome analysis by liquid chromatography-mass spectrometry (LC-MS). This method allows differentiation between taxa by identification of tandem mass spectra via *de novo* peptide sequencing and homology searching as well as a new approach comparing unidentified mass spectra by computing the similarity between datasets. Moreover, label-free quantification of peptides detects changes in the relative abundance of certain protein-candidates in response to stress. Results from a temperature experiment on*Amphistegina gibbosa* show variations in the quantity of peptides linked to physiological stress. The presented approach gives deeper insight into the compartment specific cellular responses, induced in the foraminiferal host or photo-symbionts, offering new methods to monitor stress responses in this host-symbiont system.

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STRENGTHENING THE MARITIME LOCAL GOVERNMENT NETWORK: TOWARD A SELF-RELIANT MARITIME LOCAL GOVERNMENT NETWORK TO SUPPORT CTI-CFF RPOA AND NPOA IMPLEMENTATION (Abstract ID: 28141)

Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) is a multilateral partnership of six countries to sustain extraordinary marine and coastal resources by addressing crucial issues such as food security, climate change and marine biodiversity in the Coral Triangle, which provide significant benefits to around 363 millions people reside in the region and billions more outside. CTI-CFF Regional Plan of Action (RPOA) recognizes the strategic importance of Local Governments (LGs) and communities in coastal and marine management and protection. An ongoing effort to engage local governments in the CTI-CFF process since they share the common challenge of facing the front lines of marine and coastal management with local constituents. These critical and key stakeholders in the CTI-CFF process and achievements are expected, or mandated, to conduct community level planning, adopt and implement fisheries management strategy, establish and manage marine protected areas, and to implement climate change adaptation measures. Progresses have been made and more ahead in strengthening the network capacity; prioritizing the development of a clear communication strategy to facilitate and enable interaction among members; more participation and support from non-LGs institutions and to achieving the network self-reliant and effective. A roadmap for 2015-2018 developed to include capacity building to align the local program and CTI-CFF goals; exchanges and partnership programs; institutional framework development; active membership program; and technical supports.

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DO PARROTFISH RULE MESOAMERICA? THE IMPACTS OF FISH HERBIVORY ON REEF MACROALGAL AND CORAL COVER TRAJECTORIES (Abstract ID: 28335)

Long-term phase shifts from coral to macroalgal dominated reef systems are well-documented in the Caribbean. Although the impact of coral diseases, climate change and other factors is acknowledged, major herbivore loss through disease and overfishing is often assigned a primary role. However, direct evidence for the link between herbivore abundance, macroalgal and coral cover is sparse, particularly over broad spatial scales. In this study we use a database of coral reef surveys performed at 85 sites along the Mesoamerican Reef of Mexico, Belize, Guatemala and Honduras, to examine potential ecological links by tracking site trajectories over the period 2005-2014. Despite the long-term reduction of herbivory capacity reported across the Caribbean, the Mesoamerican Reef displayed relatively low macroalgal cover at the onset of the study. Subsequently, increasing fleshy macroalgal cover was pervasive. Herbivorous fish populations were not responsible for this trend as fleshy macroalgal cover change was not correlated with initial herbivorous fish biomass or change, and the majority of sites experienced increases in macroalgae browser biomass. This contrasts the coral reef top-down herbivore control paradigm and suggests the role of external factors in making environmental conditions more favourable for algae. However, herbivorous fish, in addition to marine protection, had a positive impact on hard coral cover, which increased over the observation period, while coral cover trends were unrelated to macroalgal cover. This suggests the presence of alternative mechanisms such as reduced competitive pressure, disease prevalence, and physical damage benefiting coral communities.

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LONG-TERM CORAL REEF MONITORING IN AMERICAN SAMOA (Abstract ID: 29575 | Poster ID: 553)

American Samoa is the only U.S. territory in the South Pacific and forms the easterly part of an archipelago shared with the independent country of Samoa. Both countries share a traditional culture with historically a strong reliance on the natural environment as a source of food, in particular from the ocean. The American Samoa Coral Reef Monitoring Program has been collecting benthic and fish population data since 2006. The key goal is to monitor the status and trends in the distribution and abundance of biota on nearshore coral reefs. Using various data analyses and mapping tools the current status of coral reefs at specific sites was assessed with the aim of detecting potential temporal and spatial trends in fish and benthic community composition. Additionally, a coral reef health index was adapted and tested to assist with identifying more resilient coral reef communities in relation to watershed condition, varying levels of protection from fishing activities, and natural disturbance events such as crown of thorn starfish outbreaks, coral bleaching, hurricanes and the 2009 tsunami. Case studies are presented to highlight specific areas where the data suggest the need for further investigation and management actions to improve the health of the ecosystem.

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EVIDENCE FOR A SIGNAL TRANSDUCTION PATHWAY ASSOCIATED TO GLYCEROL SYNTHESIS IN SYMBIODINIUM (Abstract ID: 28427 | Poster ID: 115)

One of the most important aspects in the mutualistic symbioses between cnidaria and Symbiodinium, is the translocation of reduced organic carbon from the algal partner (e.g. glycerol, glucose, lipids). Host nitrogen assimilation, growth rates and calcification, are all associated to this translocated carbon. However, we do not have a clear understanding of the mechanisms involved in the stimulation and regulation of this transfer. We focused our attention to glycerol, since it represents a simple, diffusible source of carbon for the metabolism of the host, and has been considered an important translocated photosynthate. We explored the existence of a signal transduction pathway that could potentially regulate the synthesis of glycerol, with conserved elements from yeast to humans: histidine kinases for sensing, MAP kinase cascade for signal transduction and homologous transcriptional factors for gene modulation. The pathway, known as the high osmolarity glycerol (HOG) pathway in yeast, can be stimulated by osmotic or oxidative stress. We identified elements of this pathway in S. minutum through bioinformatic analysis. To validate its existence, we used (1) immunological detection of a predicted transcription factor homologous to p38 (humans) and Hog1p (yeast), (2) specific inhibition of p38 and its effect on glycerol production, (3) immunological detection of a predicted type-2 phosphatase that regulates Hog1p (anti-Ptc2), and (4) induction of glycerol synthesis in Symbiodinium under stress. We conclude that this signaling pathway may be related to glycerol synthesis in Symbiodinium.
http://www.icmyl.unam.mx/arrecifes/rsu.html

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PHOTOPHYSIOLOGICAL TRAITS ARE GLOBALLY DIAGNOSTIC OF REEF CORAL SUSCEPTIBILITY TO THERMALLY INDUCED BLEACHING (Abstract ID: 28471)

Coral symbiont (Symbiodinium spp.) diversity is a major factor regulating coral susceptibility to thermally-induced bleaching. However, the key functional traits that broadly underpin, and thus are potentially diagnostic of, thermal sensitivity amongst Symbiodinium's immense phylogeny remain unresolved. Using Symbiodinium isolates (n=18) covering broad ITS2 type diversity from clades that associate with reef corals (A-D, F), we show that active fluorescence-derived photophysiological traits under ambient growth (non-stress steady state) are highly variable amongst ITS2 types; this variability of trait expression (notably dynamic nonphotochemical energy dissipation) did not generally reflect differences in phylogeny, but was empirically related to differences in heat stress tolerance. To examine whether this relationship of steady state trait expression and thermal sensitivity was conserved for Symbiodinium in hospite, we further mined fluorescence data from corals in Australia, Brazil, Indonesia, Palau, Red Sea and Seychelles (n= 86 with >40 identified coral species-ITS2 type combinations). Consistent with our laboratory data, ~50% of variance of heat stress sensitivity could be explained by that of photophysiogical trait expression under ambient growth, thus providing the first evidence for a global diagnostic of coral thermal sensitivity independent of Symbiodinium phylogenetic identity. Our relatively simple assessment of traits expressed under ambient growth but conferring probable vulnerability to thermal events provides a new anticipative management platform.
http://www.uts.edu.au/research-and-teaching/our-research/climate-change-cluster/research-groups/aquatic-processes-group-6

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CORAL REEF RECOVERY AND RESILIENCE ON PATCH REEFS IN KANEOHE BAY, OAHU (Abstract ID: 28254)

The resilience of coral reef ecosystems has been discussed in the literature for over four decades but has been limited due to the small number of long-term studies that span decades. Increasing frequent and severe disturbances such as major weather events, fresh water kills, and increase in nutrients and sedimentation from surface runoff are causing increased stress to the Kaneohe Bay marine ecosystem. Two events initiated the recovery of coral on patch reefs; the diversion of sewage and associated nutrients outside of the Bay and the disappearance of the native invasive macroalga Dictyosphaeria cavernosa. The resilience, or the recovery of the community, may depend on the ability of remaining corals to vegetatively grow and outcompete macroalgae that once dominated. At the same time, the composition of the macroalgal and herbivore communities that occupy the reefs are critical to the outcome. In the 45 year period from the mid-1960's to 2011, mean coral cover has increased at annual rates of 1 to 4 percent in the intervals following release from competition, comparable to the published rates of recovery observed at other sites following acute disturbances. Five years after the disappearance of D. cavernosa, the two historically dominant reef building corals showed the maximum gains in percent cover. Although the presence and diversity of the other former coral species have decreased over time, the resilience of these remaining species on reef flats and reef slopes throughout the Bay may be key in the future as impacts from global climate change increase.

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PHYSIOLOGICAL RESPONSE OF SIDERASTREA RADIANS TO LOW LIGHT ENVIRONMENTS AND THERMAL STRESS. (Abstract ID: 30122 | Poster ID: 133)

The goal of this study was to describe the physiological response of the common Caribbean coral Siderastrea radians to changes in water temperature and light intensities. We conducted controlled laboratory experiments where coral fragments were exposed to treatments that combined Low (27.5°C) and High (31.5°C) temperature with Low

(200 µmol m-2 s-1) and High (400 µmol m-2 s-1) light intensities. To determine whether S. radians is affected by variations in these parameters we quantified the densities of the endosymbiotic Symbiodinium as well as protein and chlorophyll concentration. Results indicate that changes in temperature, rather than variations in light conditions, had the largest effect in the density of Symbiodinium. On the other hand, no significant differences were found when comparing proteins and chlorophylls concentration among treatment groups. The fact that, reductions in light intensities did not buffer the negative effect that high temperature has on the abundance of Symbiodinium suggest that for S. radians, turbid waters may not necessarily serve as climate-change refuges as has been proposed for other coral species.

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FROM SEA LOVING PEOPLE TO CITIZENS SCIENTISTS COMMUNITY: A CASE OF OVER TWO DECADES OF SUCCESSFUL EVOLUTION IN THE BENEFITS OF THE CORAL REEFS IN PUERTO RICO (Abstract ID: 29896 | Poster ID: 723)

Current conditions of coral reefs are in a great state of decline due to an increased demand and misuse of resources, losing their ability to self-sustain. It is critical to improve the understanding, participation and management capacity of stakeholders to protect and rehabilitate coral reefs ecosystem resilience, functions and sustainability. Non-Governmental Organization (NGO) Sociedad Ambiente Marino (SAM) has a history of more than two decades of implementing social strategies in coastal communities in Puerto Rico for engaging volunteers. The interest and desire of those who enjoy their passion for the sea are a great source of motivation to protect their resources. Sharing scientific knowledge with coastal communities through a participatory model has transformed time, motivation and energy of a group of volunteers into knowledge and action, providing them with solid tools and empowerment to fulfill their purpose in the conservation and rehabilitation of coral reefs. This has empowered SAM to develop a multiplicity of conservation-oriented projects, transforming marine conservation activities into hypothesis-driven research. SAM has produced over 70 scientific presentations in more than 12 international scientific meetings, generating over 20 peer-reviewed publications, through a wide spectrum of students and community volunteers. By changing paradigms, reversing the equation through technical empowerment, and fostering its member's professional career evolution related to marine conservation, SAM has become a role model for other small Caribbean organizations.
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SEDIMENT PRIMARY PRODUCTION UNDER EXPERIMENTAL WARMING AND ELEVATED $pCO_2$ IN SHALLOW MARINE ECOSYSTEMS OF OKINAWA, JAPAN (Abstract ID: 28554)

Environmental change challenges the structure and function of shallow marine ecosystems by stressors such as increased seawater temperature and elevated $pCO_2$. This study was designed to understand the effects of IPCC (Intergovernmental Panel on Climate Change) predicted (for the year 2100) global warming (+4°C) and $pCO_2$ (936ppm $CO_2$) on sediment primary production of coral reef lagoon, seagrass and mangrove environments. Sediment and seawater samples from each sub-environment were incubated under ambient conditions, high $pCO_2$ (936 ppm), high temperature (+4°C), and combined stresses. Neither high temperature nor high $pCO_2$ alone had a significant impact on sediment primary production. However, combined stresses increased primary production synergistically, except in coral reef lagoon. Under ambient condition respiration exceeds primary production in coral reef lagoon but stress changed this system to autotrophy. Greater uptake of silicate in sediments from each environments reflected predominant activity of diatoms. Heterotrophic community activity increased but did not exceed that of autotrophic compartments during incubation experiment. Dissolved organic carbon production and bacterial abundance increased under stress. In summary, mangrove and seagrass sediments minimize the negative impacts of combined stressors via increased primary production and carbon storage. Lagoonal sediments also act as a carbon sink under stress.

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DEVELOPING BASELINES OF CORAL SKELETAL GROWTH AND BIOEROSION FROM THE INDIAN OCEAN (Abstract ID: 28766 | Poster ID: 11)

The Natural History Museum's collections include thousands of coral specimens collected from the Seychelles, Maldives and Chagos Archipelago in the 1960s and 1970s. Prior to the 1980's global monitoring of reefs was rare, so these collections provide an irreplaceable snapshot of the coral and the endolithic boring communities present on these reefs over 50 years ago. Here I will demonstrate how we are applying non-destructive three-dimensional computerized tomography (micro-CT) on complete coral colonies to obtain species-specific growth rates, identify epi- and endobionts, and quantify skeletal bioerosion rates from these specimens. Without this historic baseline data it will be impossible to show how processes and patterns have shifted in the recent period, to what we observe on Indian Ocean reefs today.

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COMPARISON OF DIFFERENT VOLUNTARY MANAGEMENT MODELS FOR WISE USE COASTAL CONSERVATION IN HIGH USAGE AREAS. (Abstract ID: 29397 | Poster ID: 606)

Increasing populations on small islands is threatening coastal environments already being affected by climate change. Degradation is often to the detriment of low income coastal communities. The challenge for conservationists is to preserve healthy ecosystems while ensuring the financial benefit of coastal inhabitants. Voluntary Marine Conservation Areas (VMCAs) are being tested in Mauritius as a possible solution. The first attempt at a VMCA failed due to a lack of understanding by the local communities of what was required and benefits. Consequently, three other models are being tested with different degrees of involvement by the scientists, communities and tourism operators. The first model showed that with community involvement an external organisation is necessary to build capacity, guide and focus conservation efforts. The second model involved fishermen that were already switching employment to the tourism sector and gained their support quite easily. A third site involved exclusively a group of hotels. Three key points can be highlighted from these models: commitment by all stakeholders to be actively involved is needed for successful conservation; tangible short term and long term benefits to local communities; long term funding for effective on-going management. Could sustainable management of coastal environments be led by the tourism industry? Could this model be expanded to benefit neighboring communities through capacity building to provide alternative sources of income?

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VERTICAL MOVEMENT PATTERNS OF JUVENILE WHALE SHARKS*RHINCODON TYPUS* AT A SEASONAL AGGREGATION IN SAUDI ARABIAN RED SEA (Abstract ID: 28832 | Poster ID: 515)

Large marine species have been a focus of scientists and the public for their unique role in the ecosystem as well as in conservation. To study the behaviors of large marine species, electronic tagging is a direct and reliable method. Researchers have been utilizing technological advances in biologging tags on multiple spatiotemporal scales. This study provides a detailed insight into the vertical movement of whale sharks in a newly described seasonal aggregation concentrated on a coral reef near the coast of Al Lith in the Saudi Arabian Red Sea. Two biologging tags were fitted on two juvenile whale sharks over a period of 22 hours each. Fine-scaled diving behavior was recorded with a sampling rate of 10 Hz and energy consumption was generated from 3D acceleration sensor data. Tagged whale sharks exhibited intensive and consistent diving behaviors throughout the day except for a period of prolonged surface swimming in the morning and a brief surfacing period around sunset. In multiple stages of the diel cycle, whale sharks utilized different depths in the water column, most possibly optimizing energy consumption from foraging efforts. Combined with previous studies on horizontal movement of whale sharks in this aggregation, this study reveals one of the most comprehensive pictures of the movement behaviors of juvenile whale sharks. We hope this study will benefit the management of this hotspot of whale sharks and even larger-scale ecosystems, revealing the potential consequences of excessive human activities (e.g. ecotourism, aquaculture) and global climate issues.

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HERBIVOROUS FISH SELECT MACROALGAE ON FRINGING REEFS IN MO'OREA, FRENCH POLYNESIA (Abstract ID: 29945 | Poster ID: 283)

Current research on herbivorous fish in coral reef communities has focused on species identities and functional redundancy and complementarity. Identifying functional redundancy is important for assessing the resilience of specific coral reefs. My objective was to determine species-specific grazing by herbivorous fish on different macroalgal species on fringing reefs in Mo'orea, French Polynesia. I deployed bioassays of seven common macroalgae on a fringing reef. Video cameras recorded bioassays and provided fish species identity and bite rates on the different macroalgae. Herbivorous fish took more bites of Padina boryana (56% of all bites) and Sargassum mangarevense (28% of all bites) than the other macroalgae presented. Similarly, of the 208 individual fish observed taking bites, 57% of them bit Padina, while 33% of them bit Sargassum. For scarids, including Calatomus carolinus, 99% of observed bites were on 2 of the 7 macroalgae (Padina and Sargassum). In comparison, for acanthurids, including Acanthurus nigrofuscus, Ctenochaetus striatus, and Naso literatus, 91% of observed bites were on Padina and Sargassum and 8% were on an additional 3 macroalgae (Dictyota sp, Turbinaria ornata, and Galaxaura sp). However, the majority of bites on Dictyota and Acanthophora spicifera were by the striped triggerfish, Balistapus undulatus. Overall, Padina and Sargassum are highly selected for by herbivorous fish, and acanthurids and scarids predominantly consume the same macroalgae. This knowledge is useful for the appropriate management of herbivorous fish communities on coral reefs.

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IMPACTS OF MACRO ALGAE ON THE CORAL TRANSPLANTATION/RESTORATION EFFORTS IN THE GULF OF KACHCHH, NORTH-WEST COAST OF INDIA (Abstract ID: 28159 | Poster ID: 467)

Southern shore of Gulf of Kachchh encompasses 42 islands with unique faunal and floral diversity. Its semi-diurnal tidal amplitude fluctuations coupled with heavy sediment depositions make a major portion of the Gulf to expose and left the region without any major reef formations. Moreover, effluents from various types of petrochemical, fertilizer, ship building, thermal power industries and dependent human populations, bordering the shore turning Kachchh more and more eutrophic, leading to exponential growth of macro algae in the coral reef areas. Over growth of macro algae on coral reefs leads to community 'phase shifts' and subsequent ecosystem degradation. As a part of improving the quality of coral reefs through restoration efforts, an area of about 1000m2 was restored in the three spatially distinct sites along the Gulf with native as well as branching coral transplants, which extirpated thousands of years ago. These restoration efforts were stressed considerably due to the ever increasing macro algal growth especially during post monsoon and winter months, which not only cut off much needed light for corals but also compete for space. A total of 69 macro algal species were recorded on the artificial coral restoration structures during the study period. Density of macro algae varied from 0.03%/m2 to 0.08%/m2. Site specific ocean engineering interventions were introduced to curb the menace to possible extent. Seasonal variation, diversity and distribution of macro algae in three sites were studied. Strategies and recommendations to counter the menace of macro algae to enhance the coral growth on the reefs of the Gulf and similar impacted areas are discussed.

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DYNAMIC MODEL OF CORAL REEFS ECOSYSTEM MANAGEMENT AT THE PRAMUKA ISLAND, THOUSAND ISLANDS MARINE NATIONAL PARK – INDONESIA (Abstract ID: 28044 | Poster ID: 446)

The increasing number of tourists since 2003 and the development of community-based tourism in protected areas of Pramuka Island in the Thousand Islands Marine National Park caused the pressure on the quality of resources, especially coral reefs ecosystem and also the pressure on the environment. Therefore required a strategy of sustainable management of coral reef resources for tourism activities and coral reefs resources to be sustainable. This study aim is to build a dynamic model of management strategies that can be relied upon in doing the management of coral reef resources in Pramuka Island. Simulations was carried out on 5 scenarios. Based on multicreria analysis of all scenarios using trade-off analysis that scenario E is the best mangement for sustainability of coral resources at Pramuka island. Management of biology sub-system, marine environments sub-system and socio-economic sub-system are closely related to one another and should be implemented in an integrated manner to ensure the sustainability of coral reef resources. Integrated management of coral reef ecosystem at Pramuka island include the management of the factors that threaten coral reefs; minimum fee into conservation areas of Pramuka Island of Rp 36 000,00 (US$ 3.6) for the tourist; minimum wastewater treatment by 30% before being discharged directly into waters. Integrated management not only ensure the sustainability of coral reef resources, but also to ensure social and economic sustainability at Pramuka Island.

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MARINE TOURISM IMPACT ON CORAL REEFS IN SERIBU ISLANDS NATIONAL PARK, INDONESIA (Abstract ID: 27943 | Poster ID: 617)

The beauty of coral reef ecosystem is tourist attraction that could generate significant local and regional revenues. However, coral reef ecosystem also has high levels of vulnerability to human impact such as marine tourism activities. Kicking, trampling, touching, and physical contact with divers and their diving gears are the four identified tourist behavior potentially damage the corals. Objective of this study was to assess impact of marine tourism activities on coral reef ecosystem in Panggang sub-district of Seribu Islands National Park, Jakarta, Indonesia. Data were collected through direct survey, observation, and interview with tourists, tourist guide, and local community. This study revealed that coral covers in this area are under bad to medium condition with low level of mortality. Kicking coral is the most often done by tourist during diving and trampling during their snorkling. Annual potential damage due to snorkeling and diving to coral cover in the study area are about 7.6% and 8.2%, respectively. This study provides strategies to minimize impact from marine tourism activities.

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CORAL DISEASE ETIOLOGIES AS MOVING TARGETS: A 20-YEAR CASE STUDY OF WHITE POX DISEASE IN THE FLORIDA KEYS, 1994-2014 (Abstract ID: 28805)

The moving target hypothesis describes the etiology of a contemporary coral disease that differs from that of its historical disease state. Hitting the target with coral disease etiology is a complex pursuit that requires understanding of host and environment, and may lack a single pathogen solution. White pox disease (WPX) affects the Caribbean coral Acropora palmata. Acroporid serratiosis is a form of WPX for which the bacterial pathogen (Serratia marcescens) has been established. We used long term (1994-2014) photographic monitoring and molecular analyses to evaluate historical and contemporary epizootiology and etiology of WPX affecting A. palmata at eight reefs in the Florida Keys. Ranges of WPX prevalence over time (0% to 71.4%) were comparable for the duration of the 20-year study. Whole colony mortality and disease severity were high in historical (1994-2004), and low in contemporary (2008-2014), outbreaks of WPX. Acroporid serratiosis was diagnosed for some historical (1999, 2003) and contemporary (2012, 2013) outbreaks, but this form of WPX was not confirmed for all WPX cases. Our results serve as a context for considering etiology as a moving target for WPX and other coral diseases for which pathogens are established and/or candidate pathogens are identified. Coral etiology investigations completed to date suggest that changes in pathogen, host, and/or environment alter the disease state and complicate diagnosis.

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PRECAUTIONARY APPROACH FOR CORAL REEF CONSERVATION IN A RAMSAR SITE IN THE GULF OF THAILAND (Abstract ID: 28684 | Poster ID: 675)

Mu Ko Ang Thong, an archipelago in the Gulf of Thailand, was established as a marine national park in 1980 and was also registered as a Ramsar site in 2002. The park consists of 42 islands and covers a total area of 102 $km_2$. The main islands are Phaluai, Ang Thong (Wua Ta Lap), Wua Ta Lam (Mae Ko), Sam Sao, Hin Dap, Nai Phut and Phai luak. This case study provides a precautionary approach for coral reef conservation in Mu Ko Ang Thong National Park, a Ramsar site, in the Western Gulf of Thailand . The islands are surrounded by relatively shallow and turbid water which is greatly influenced by river water from the mainland. The coral reefs on the islands are not well developed

and were restricted to a narrow band around each island. The most popular tourist attractions are a viewpoint at the top of Ko Ang Thong and a huge emerald lagoon situated in the middle of the limestone mountain in Ko Wua Ta Lam. Canoeing, kayaking and snorkeling are also popular tourist activities at some islands. Coral damages caused by tramping and high sedimentation were frequently observed. Assessing coral health and resilience in the national park was carried out to provide scientific data for establishing a master management plan. The management strategies include coral reef zoning for multiple uses, effective tourism management and prevention of land-based pollution. This study highlights the importance of science-based management of coral reefs in marine protected areas for sustainable tourism in Thailand.
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INTERSPECIFIC AND SPATIAL COMPARISONS OF INITIAL POST-SETTLEMENT SURVIVAL FOR *ACROPORA* SPATS USING A GRID PLATE (Abstract ID: 28313)

Direct seeding of coral larvae could accelerate recovery of coral assemblage after disturbance. However, the spatial or interspecific tendency of post-settlement survival (PSS) remains uncertain due to the difficulty of direct observation of coral spats on natural substratum. To evaluate PSS of coral spats at initial stage, we compared the PSS of artificially settled *Acropora*spats on a lattice-structured plate (hereafter, grid plate), which is suitable for coral settlement and growth. We used 3 species; an upper slope dominant *A. digitifera*, a lower slope dominant *A. tenuis*, an inner reef dominant *A. yongei*, for interspecific comparison. Larvae of each species were quantitatively settled on a grid plate, and the number of living spats was counted at 3d, 1mo, 3mo, 6mo, and 15mo after settlement. We clarified significant differences between species; the PSS of *A. digitifera* was 0.9% at 6mo after settlement, whereas that of *A. tenuis* was 24.6% at same time. Second, we set 40 grid plates at 5 different coral cover sites. The number of living spats was counted at the same timing with the first experiment, and the size of each spat was measured at 15mo after settlement. We found that the average spat sizes in the high coral cover sites was significantly larger than those in the low coral cover sites, whereas the PSS was not different among sites. These results suggested that direct seeding may be a useful method for restoring a certain*Acropora* assemblage because the PSS was not reduced even in the low coral cover sites.

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PRODUCTION OF CYCLO-ENOL IN CORAL BLEACHING: A STRATEGY TO AVOID OXIDATIVE DAMAGE (Abstract ID: 28147 | Poster ID: 114)

We examined the morphology and pigment composition of zooxanthellae in corals subjected to normal temperature (27 °C) and thermal stress (32 °C). We observed several normal and abnormal morphological types of zooxanthellar cells. Normal cells were intact and their chloroplasts were unbroken (healthy); abnormal cells were shrunken and had partially degraded or broken chloroplasts, or they were bleached and without chloroplasts. At 27 °C, most healthy zooxanthellar cells were retained in the coral tissue, whereas shrunken zooxanthellae were expelled. Under thermal stress, the abundance of healthy zooxanthellae declined and the proportion of shrunken/abnormal cells increased in coral tissues. The rate of algal cell expulsion was reduced under thermal stress. Within the shrunken cells, we detected the presence of a chlorophyll-like pigment that is not ordinarily found in healthy zooxanthellae. Analysis of the absorption spectrum, absorption maxima and retention time (by HPLC) indicated that this pigment was $13^2$, $17^3$-cyclopheophorbide *a* enol (cPPB-*a*E, cyclo-enol), which is frequently found in marine and lacustrine sediments, and in protozoans that graze on phytoplankton. The production of cyclo-enol in shrunken zooxanthellae suggests that the chlorophylls have been degraded to cyclo-enol, a compound that is not fluorescent. The lack of a fluorescence function precludes the formation of reactive oxygen species. We therefore consider the formation of cyclo-enol in shrunken zooxanthellae to be a mechanism for avoiding oxidative stress.

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ROLE OF CORAL REEF SCIENCE FOR CONSERVATION UNDER THE MULTIPLE STRESS (Abstract ID: 28603 | Poster ID: 727)

Coral bleaching and disease are the most impacting process that is affecting coral survival under elevated sea surface temperature, high irradiance scenario, high-CO2 and also infection of bacteria. However its mechanism is not well understood. This is due to the high complexity of the coral symbiosis and metabolisms and multiple stressors. Over the past 10 years MC (Mitsubishi Co.) project team has worked towards identifying environmental stressors affecting the health of the corals, resulting in coral bleaching and diseases at several reef areas of Okinawa. The scope of the research varies, from field-monitoring and socio-ecological impacts on coral reefs to laboratory-based experiments to decipher mechanisms of coral reefs that can reveal health and stressful conditions. The projects provide outstanding opportunities to engage citizens, students and young scientists in field and laboratory research. We had successfully identify and clarify bleaching mechanisms and several coral diseases common in our study area and had shown that anthropogenic stresses (as input of nutrients and pathogenic microbes) in combination with environmental stresses (as high sea-surface temperature) can result in amplified effects causing reef deterioration and face shifts. These results can influence and change policies directly relating to marine and reef based issues, and also to increase awareness of the value of marine ecosystems to communities, policy makers and governments.

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SYMBIODINIUM THERMOTOLERANCE AND CORAL SUSCEPTIBILITY TO BLEACHING (Abstract ID: 28751)

Twenty-five years of genetic assessment of *Symbiodinium* diversity has revealed nine clades circumscribing more than 400 phylotypes, and fostered a nascent understanding of sub-phylotype diversity and population genetics. This diversity is meaningful for their symbiotic associations with corals, as the subset of phylotypes that have been assessed may differ in their physiological capabilities to acquire nutrients, produce photosynthetic products, and resist oxidative and thermal stress. These physiological differences translate into differential bleaching susceptibility of the holobiont and allow corals associated with thermotolerant phylotypes to persist under thermal conditions that would otherwise cause bleaching. This increased resistance is often associated with a tradeoff that may limit the optimal frequency of association with thermotolerant phylotypes to periods of thermal stress. Although the effects of *Symbiodinium*thermotolerance on bleaching susceptibility is a central focus of ongoing research, our ability to apply these data to conservation or remediative efforts is limited by the scope of comparable information across phylotypes. Here we present a novel quantitative index of thermotolerance for 110*Symbiodinium* phylotypes based on an iterative partial-rank aggregation method of consensus estimation from available qualitative partial rankings. This new framework for analysis will allow quantitative assessment of hypotheses on the effects of *Symbiodinium* thermotolerance on coral bleaching.

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QUANTITATIVE ASSESSMENT OF ESA CORAL POPULATIONS AND THE APPLICATION OF RESOURCE SELECTION THEORY (Abstract ID: 28841)

The status and extinction risk determinations leading to the decisions to list 22 coral species as threatened under the U.S. Endangered Species Act (ESA) were based on sparse observational data of species distributions, abundances, and vulnerabilities to a diverse range of threats. The listing process demonstrated the general lack of adequate ecological and demographic information for most coral species and the limitation in our collective ability to answer questions about the status of all coral populations or assess potential impacts. Yet, managers need to know the status of threatened species in specific geographic areas to address ESA compliance, manage risk, establish or improve the effectiveness of marine protected areas, and identify potential areas for coral restoration and recovery actions. This study uses existing spatially-explicit datasets and applies the theory of resource selection to quantitatively assess the status of threatened coral species within the Florida Coral Reef Tract. This assessment incorporates benthic habitat maps and coral abundance, size, and condition data in a step-wise process to determine population-level estimates and habitat use (spatial habitat estimates) within the ecosystem. Habitat use analysis can quantitatively address a suite of management needs for threatened coral species. Since a species' habitat use has ties to population regulation (recruitment, growth, mortality) and persistence over time (productivity), spatial patterns of habitat use infer spatial variation in overall productivity.

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DYNAMIC CHANGES IN THE CORAL MICROBIOME WITH COLONY AGE: IMPLICATIONS FOR ACCLIMATISATION AND ADAPTATION (Abstract ID: 28068)

Recent studies, using the massive coral Coelastrea aspera, have shown significant changes in microbial diversity over temporal scales ranging from days (within a tidal cycle) to years (when different coral age-groups were compared). Dramatic alterations in the coral's microbial associates occurred over a 4 day period during a spring tide where corals were aerially exposed and subject to large fluxes of seawater. Baseline differences in bacterial communities in C. aspera were also evident between different age groups with a step-wise increase in bacterial richness as the corals aged. Such changes resemble a successional process similar to that seen in ageing higher organisms. The pattern of changes detected over a tidal cycle in 4 and 9-10 year old corals was also markedly different. Microbial associates of younger corals changed rapidly in response to altered environmental conditions while those of older corals remained stable during the early stages of the tidal cycle, changing only when challenging physical conditions ameliorated. Explanations for the latter observations may involve variations in the initial composition of the microbiome of different age-groups, bacterial interactions and host energetics, particularly with respect to mucus supply and composition. Older corals are likely to expend more energy in reproduction, sediment-shedding and lesion-healing than younger corals. Our results highlight the little-studied changing physiology of corals throughout their life-history with implications for their scope to adapt/acclimatise in a changing world.
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NON-INTRUSIVE P700 REDOX KINETICS PROBE TO DETERMINE THE FUNCTIONALITY OF BOTH PHOTOSYSTEM II AND PHOTOSYSTEM I IN WHOLE CORAL TISSUES (Abstract ID: 28231)

The productivity of coral reefs depends on the symbiosis of cnidarians and photosynthetic dinoflagellates from the genus Symbiodinium. Thus, assessment of photosynthetic capacity of the endosymbiont alga is crucial in understanding the function of the holobiont. Non-invasive techniques such as chlorophyll (Chl) fluorescence analyses have been widely used to estimate the photosynthetic performance of Symbiodinium in hospite. However, since the spatial origin of the fluorescence in coral tissues is uncertain, the signal gives no information on photosynthetic performance of the whole tissue. By contrast, detection of absorbance changes in the near infrared (NIR) region samples greater tissue depths due to weak absorption and multiple scattering of NIR light in coral tissues. While extensively utilised in plants, these bio-optical techniques are seldom applied to corals. In this study, we sought rapid, non-intrusive measurements of redox kinetics of the special Chl pair in Photosystem I (P700) in intact corals. Since the redox state of P700 depends on the operation of both Photosystems I and II (PSII and PSI), important information can be obtained about the functionality of sections of the electron transfer chain. In the current study, by using P700 redox kinetics we aim to i) advance the knowledge on PSII-PSI inter-system electron transfer capacity in Symbiodinium in hospite, in whole coral tissues, and ii) explore how PSI-PSII coupling and stability can start to untangle our understanding on processes downstream of PSII that may govern bleaching- induced PSII dynamics.

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EVALUATION OF SIZE-FRACTIONATED PARTICULATE ORGANIC MATTER AS A FOOD SOURCE FOR CROWN-OF-THORNS STARFISH LARVAE (Abstract ID: 29184 | Poster ID: 216)

An explosive increase in the number of the crown-of-thorns starfish (*Acanthaster plaunci*) has been reported in various reef areas, causing severe feeding damage on corals and economic strain for management. One of the major hypotheses to explain such a population explosion is increased larval survival due to enhanced availability of phytoplankton. In Okinawa, however, the explosive increase has often occurred under the condition in which chlorophyll-a (chl-a) concentration was lower than larvae's demand, implying that the larvae feed on not only phytoplankton but also other organic particles. The present study, therefore, intended to evaluate the possible importance of particulate organic matter (POM) by analyzing both chemical and biological compositions by rearing experiments of the larvae. The POM sample collection was conducted at Sesoko Island, Okinawa, Japan in July 2015. In addition to Concentrations of chl-a, bacteria and flagellate were determined either fluorometrically or microscopically and their values were converted to carbon amounts. As a result, non-living organic matter, or detritus, shared 53.1 to 93.1 percent to the total carbon, while phytoplankton-derived carbon ranged only 7.0 to 20.7 percent and never exceeded the energy demand of the larvae. Our results indicated that the carbon amount of living materials including bacteria and flagellate was not sufficient enough to ensure the high survival rate of the larvae, and thus detritus likely contributed as an important carbon source.

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MOLECULAR CYTOGENETIC STUDY ON SCLERACTINIAN CORAL COELASTREA ASPERA (VERRILL 1865) (Abstract ID: 29095 | Poster ID: 497)

Molecular cytogenetic study on the scleractinian coral Coelastrea aspera (Verrill 1865), was performed, which commonly distributes along temperate coasts in Japan (30–35°N) and in coastal oacean areas in the Indian and Pacific oceans. G- and C-bandings of C. aspera was successfully done, though the banding patterns are not clear enough as that of in mammals. It is of interest that this coral had a homogenously staining region (hsr) in chromosome #11 based on its karyogram. This hsr derived from rDNA related genes which was demonstrated by fluorescence in situ hybridization (FISH) with the probe generated using the rDNA primers, chromosome microdissection and the following FISH techniques. We also confirmed that the hsr was not positive by Ag-NOR staining. This coral C. aspera had the hsr close to 50% of the metaphase spread analyzed. This observation of the presence of an hsr may explain the diversity of coral rDNA which suggested by molecular study of sequence analysis. Furthermore, we found that human telomere and Alu repeated sequences were present in this coral C. aspera. Accordingly, probes derived from human Alu sequences expect to play an important role in classifying scleractinian corals. Overall, our findings can be of value in taxonomy of scleractinian coral species and developing coral genetics, including chromosomal evolution.
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POTENTIAL CHANGES IN CORAL DISPERSAL AND CONNECTIVITY IN THE EAST CHINA SEA UNDER FUTURE CLIMATE SCENARIOS (Abstract ID: 28691)

Changes in current patterns and speeds of the Kuroshio Current and its branches would affect the latitudinal limits and/or distributions of subtropical and temperate coral species in the East China Sea, due to changes in the dispersal rate of these species. Using an offline particle-tracking model coupled with a one-way, doubly-nested eddy-resolving ocean model based on the Regional Ocean Modeling System (FRA-ROMS), we simulated early summer coral-spawning events in the East China Sea. To gain insights into potential changes in coral dispersal and connectivity in this region, the particle-tracking simulations were performed under historical and two global warming scenarios (RCP2.6 and 8.5) for three periods (1996-2005, 2026-2035, and 2086-2095). Results under the historical simulation suggest that Ryukyu Islands would be important sources of coral larvae for islands south of Kyushu. Furthermore, coastal areas of Taiwan and China may be remote sources for the western coastal areas of Kyushu and Tsushima Island, where world's northernmost coral reefs exist. Under the RCP8.5 scenario, on the other hand, an enhanced countercurrent in the south of Ryukyu Islands would limit the poleward expansion of corals from Ryukyu Islands to islands south of Kyushu. These results suggest that strategies for conserving corals in the East China Sea will need to consider future changes in current patterns as well as the other environmental factors such as rise in water temperatures.

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SIMPLE RULES FOR ESTABLISHMENT OF EFFECTIVE MARINE RESERVES (Abstract ID: 28056 | Poster ID: 651)

Marine reserves often play a central role to guarantee sustainable fisheries management and improve fisheries benefit. Even though many studies have been conducted to understand how marine reserves are introduced effectively, deducing theoretical conditions

guaranteeing that the introduction of marine reserves will increase fisheries yields can still have potential to improve our insight significantly. Deriving these theoretical conditions in mind, a simple mathematical model is developed that follows an age-structured metapopulation dynamics of a sedentary marine organism where each population is connected by the dispersal of eggs. The obtained simple results suggest that a sufficiently high fishing mortality rate and moderate recruitment success of an individual's eggs is a necessary for marine reserves to increase fisheries yields. The numerical calculations are also conducted with the parameters of red abalone (*Haliotis rufescens*) to visualize the obtained results.

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DRIVERS FOR BENTHIC METABOLISM AND ITS FEEDBACK TO CARBONATE CHEMISTRY ON A CORAL REEF IN BERMUDA (Abstract ID: 29050)

It is well documented that the bulk seawater chemistry over a coral reef is significantly modified through benthic metabolism (i.e. net community production (ncp) and net community calcification (ncc)). However, the relative importance of the various factors that influence the water chemistry such as metabolism, advection, and depth is still not fully understood. Here, we present autonomous measurements of ncp and ncc made every 10 minutes at Hog reef in Bermuda between July 26 and 29, 2015. The metabolism rates were measured using the Benthic Ecosystem Acidification and Metabolism System (BEAMS), a novel system which utilizes pH and O2 gradients in the benthic boundary layer to quantify the benthic metabolic fluxes. Both ncp and ncc were highly dependent on light levels, reaching on average 20 mmol O2 m-2 hr-1 and 5 mmol CaCO3 m-2 hr-1 when irradiance was 500 micro quanta m-2 s-1. We interpret the effects of the benthic metabolism on the water chemistry over a large spatial context (several km2) using distributions of surface total alkalinity and dissolved inorganic carbon, in addition to three autonomous pH and O2 sensors deployed across a depth gradient located several km apart.

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HISTORICAL RUNOFF SOURCES TO PELEKANE BAY, SOUTH KOHALA, HAWAI'I: IMPLICATIONS FOR REEF HEALTH (Abstract ID: 29829)

Sedimentary records can provide insight about physical processes that influence the structure and function of coral reefs, such as terrestrial sediment runoff. On the south Kohala coast of the Island of Hawai'i, coral reefs flourished for more than 400 ka but are today variably impacted by sediment. Archaeological studies at Pu'ukohola Heiau National Historic Site describe shoreline progradation at the head of Pelekane Bay arising from land-clearing by early Hawaiians. Land use practices of the 19th and 20th centuries likely accelerated sediment runoff, and harbor construction reduced oceanic flushing. As a result, terrestrial sediment has recently accumulated in Pelekane Bay and on the reef, decreasing species richness. The goal of this study was to identify historical sediment sources to Pelekane Bay by comparing sediment trace and rare earth element signatures in reef sediment and uplands. Upland sediment derives from weathering of basalt and alkalic lavas that are geochemically and geographically distinct from each other. A sediment core collected from the reef flat and dated with 210Pb and 137Cs shows that for the past 50 yrs terrestrial sediment in Pelekane Bay had a basaltic signature similar to that at lower elevations of the watershed. The predominance of sediment runoff from the lower watershed suggests that watershed restoration and runoff control efforts aimed at improving reef health should target these regions. Recent conservation efforts in Pelekane watershed appear to have reversed precipitous declines in coral and fish communities.

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*ACROPORA TENUIS* LECTIN ATTRACTS SPECIFIC *SYMBIODINIUM* CULTURE STRAINS (Abstract ID: 29376)

Most reef-building corals acquire symbiotic dinoflagellates, *Symbiodinium* spp., from surrounding environments and establish symbiosis with *Symbiodinium*. Since *Symbiodinium* occur in low densities in the water column, corals would attract symbionts using chemotactic compounds to acquire them. We found a coral *Acropora tenuis* crude water extract attracted specific Symbiodinium strains, including strains NBRC102920 (clade A) and CCMP2556 (clade D), but not strains GTP-A6-Sy (clade A), CCMP421 (clade E) and CS-156 (clade F). The chemotactic activity in crude *A. tenuis* water extract remained after dialysis, but lost completely after heat treatment, indicating that the chemotactic compounds are water-soluble, heat-labile macromolecules. Juvenile *A. tenuis* tend to acquire the strains which attracted by the crude water extract, so chemoattraction seems to be inhibited by inhibitors of acquisition, like *N*-acetyl-D-glucosamine (GlcNAc). As expected, GlcNAc inhibited the chemotactic activity and thus, a candidate of a chemoattractant is a GlcNAc binding lectin. The lectin purified from crude water extract, ActL, demonstrated 70% of the chemotactic activity in the crude water extract. The attracted strains by ActL were same as those by crude water extract. As mentioned above these strains were acquired by juvenile *A. tenuis*, suggesting that chemoattraction is an important step for acquisition to establish symbiosis between corals and *Symbiodinium*.

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SEXUAL REPRODUCTIVE PATTERNS OF COMMON BRANCHING CORAL, ACROPORA NOBILIS, ON THE COASTS OF PENINSULAR MALAYSIA (Abstract ID: 29052 | Poster ID: 174)

Sexual reproduction is an essential element in population viability for the scleractinian coral. However, the information on sexual reproduction of scleratinian coral in Malaysia is scarce. Here we investigated the spatial variation in sexual reproductive characteristics of common branching scleractinian coral, *Acropora nobilis*, from east (Redang Island) and west (Sembilan Group of Islands) coasts of Peninsular Malaysia. *A. nobilis* is a hermaphroditic coral with both ovari and sperm bundle were observed in the same colony. High proportion (89%) of the *A. nobilis* colonies at islands of west coast were found fecund in January 2015. Oocytes size ranged between 130 μ m and 250 μ m. The oocytes size suggested that ovary were still in developmental stage. Similarly, small immature spemary sacs were found in testes of *A. nobilis* samples from the west. On the other hand, colored oocytes were found in samples from the Redang Island in September with average size over 500 μ m. From the oocytes size and testes development condition, *A. nobilis* colonies at the west coast of Peninsular Malaysia were predicted to spawn in March or April, which was different from the predicted spawning time (in September and October) for *A. nobilis* at east coast. The spatial variation in reproductive patterns observed here could be an adaption of allopatric population to local environment.

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MAPPING SCLERACTINIAN CORAL COMMUNITIES OF SINGAPORE USING THE GEOGRAPHICAL INFORMATIONS SYSTEM (GIS) (Abstract ID: 27919 | Poster ID: 78)

The scleractinian reef communities of 44 fringing and patch reefs located south of Singapore mainland were studied using Line Intercept Transact. Altogether 118 sites accounting for a total of 11.9 km of reefs were surveyed. Results indicate that high species diversity still exists in Singapore, with a total of 53 genera of hard corals representing 17 families and 141 species (including non-scleractinian reef-building *Heliopora* sp. and *Tubipora* sp.) documented. Live coral cover at the reef crest was found to fluctuate widely between reefs, ranging from 4.47% to 78.71%. About 63% of the 118 transacts showed live coral cover of > 30%. Diversity indices, species evenness and abundance measures were used to determine the ecological state of the reefs, and results were incorporated into a GIS basemap using ESRI® ARCGIS. Multivariate nMDS ordination indicated a loose clustering of the reefs into four main groups with similar scleractinian coral assemblages. Human activities in the area around the reefs were also mapped to assess their impacts on the reefs. Spatial analysis highlighted a possible link between anthropogenic activities in close proximity to the coral reefs, and diversity, evenness and coral abundance indices. The preliminary GIS basemap in this current study is a first for Singapore, and one of the most direct and useful applications is establishing linkages between mapped variables. As more data from future research is incorporated, this basemap could be a useful tool for management decisions on conservation and development.

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EFFECTS OF NITRATE AND PHOSPHATE AVAILABILITY ON THE BIOMASS, STABLE CARBON ISOTOPES, AND GROWTH RATES OF THE SCLERACTINIAN CORALS (Abstract ID: 28498 | Poster ID: 117)

The scleractinian corals *Montipora digitata* and *Porites cylindrica* were cultured in filtered seawater in the laboratory, and the effects of nitrate and phosphate availability on their physiological status were evaluated. Carbon (C) biomass of the endosymbionts was higher in the nitrate + phosphate (+NP) treatment than in the control but the enhancement was not observed for the animal host C. Nitrogen (N) biomass was higher in the +NP treatment than in the control for both the animal host and endosymbionts. These results suggest that seawater-derived inorganic N was incorporated into the host and endosymbionts as organic N but the N incorporation into the host proceeded using organic C stored in the host tissue. Stable C isotopes (δ13C) in the host and endosymbionts decreased in all of the treatments during the study, suggesting that the coral was catabolizing heavier isotope lipids resulting in the animal δ13C value decreasing. The decrease in δ13C was enhanced by the addition of nutrients, suggesting that the endosymbionts in additional nutrient treatments were reliant on host-derived dissolved inorganic C more than those in the control treatment. The nutrient addition decreased the calcification rates of *P. cylindrica* but not *M. digitata*. The present experiment concludes that when coral heterotrophy is reduced, inorganic nutrients become an important factor to affect the coral physiological status.

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EVALUATION OF THE CONTRIBUTION OF CORAL-DERIVED ORGANIC MATTER TO TOTAL SEDIMENTARY ORGANIC MATTER BY ELEMENTAL AND ISOTOPIC ANALYSIS (Abstract ID: 27942 | Poster ID: 89)

The carbon sequestrated in marine ecosystems has been termed "blue carbon". Coastal ecosystems are the most dominant blue carbon stocks, contributing to the mitigation of global warming. Recent studies have revealed that the amount of sedimentary organic matter (SOM) in tropical and subtropical coasts is comparable to temperate SOM. Understanding the origins of SOM is important to conserve these blue carbon stocks. Seagrasses, terrestrial plants and microalgae have been considered as origins of SOM but little attention has been given to corals although they are some of the major primary producers and the major components of sediments in tropical and subtropical coasts. Using sediment core samples and organisms taken from fringing reefs, located around Ishigaki island, Japan, we analyzed the elemental and isotopic ratios (carbon and nitrogen) of SOM and major primary producers including corals. We then calculated the contribution of coral-derived organic matter to total SOM using a Bayesian mixing model. We took sediment core samples from seagrass meadows and non-vegetated two areas near the seagrass meadows and coral colonies on the reef flat. Also, we collected dominant corals (*Heliopora coerulea*, massive and branching *Porites spp.* and branching *Acropora spp.*) from near the shore to the reef crest. Results showed that the $\delta^{13}C$ value and C/N ratio of SOM were lower than those of seagrasses, indicating that other organisms such as corals and microalgae may account for the origin of SOM in addition to seagrasses.

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RESPONSE OF FAVITES COLEMANI LARVAE TO OCEAN WARMING AND ACIDIFICATION (Abstract ID: 29171 | Poster ID: 202)

Coral susceptibility to environmental stressors is deemed to be greater during the dispersive larval stage. However, there have been few studies exploring the vulnerability of coral larvae to ocean warming and acidification. In this study, we investigated the acidification and thermal stress response of Favites colemani from Bolinao-Anda Reef Complex, Philippines. Three-day old larvae were exposed to present day and predicted IPCC near-future ocean pH levels (8.1, 7.8, 7.6) cross-factored with seawater temperatures (27C, 30C, 33C). Larval survival was recorded after short (3d), and long (10d) term exposure to treatments. Larval metamorphosis and survival were also determined under induced metamorphosis (with crustose coralline algae) after 3d exposure to treatments. Results suggest that increased temperature and decreased pH did not significantly affect survival for both 3d and 10d exposure to these stressors. However, larvae exhibited decreased tolerance to combined pH and thermal stress after 10d exposure. During metamorphosis stage, survival was significantly lower than during larval swimming stage; with significant decrease under both thermal stress, and combined pH and thermal stress. Metamorphosis rates were also relatively lower under high thermal stress, and under combined low pH-high thermal stress; although not statistically significant. These findings indicate that elevated seawater temperatures in synergy with decreased pH pose greater detrimental impact on F. colemani larvae, and that its sensitivity to these stressors heightens during metamorphosis.

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CHARACTERISTICS OF WHALE SHARKS (RHINCODON TYPUS) IN TELUK CENDERAWASIH NATIONAL PARK, INDONESIA (Abstract ID: 30068 | Poster ID: 272)

The whale shark (Rhincodon typus) is an iconic species for Teluk Cenderawasih National Park (TCNP), West Papua and Papua. They have appeared regularly near lift-net fisheries (bagans) year round in some areas, especially near Kwatisore in West Papua, resulting in the development of limited tourisms since 2009. The objective of our study was to document the characteristics (i.e., number, size, sex) of whale sharks that occur in TCNP. We used photographs to identify whale sharks, from natural patterns (white spot pattern) and other body markings. We also made subjective estimates of the relative sizes of each shark and determined whether they were male or female from the presence or absence of claspers. We obtained, 8.530 photos of sharks from February 2010 through June 2015. From that database we tentatively identified 126 sharks, 83% of them male, 14% female and 3% undetermined. The estimated length of the sharks averaged 4.4 m (± 1.25 m, range = 2 m to 8 m). Around 40% of the individuals had scars, mostly around their mouths and fins. Most (59%) of the sharks were seen in only one year with 3% seen in more that one year during the five year study. Juvenile male whale sharks appear to be transient and highly mobile in Cenderawasih Bay. Because of the increased tourism for whale sharks and the interactions of whale sharks with the fishing bagans, we recommend continued systematic observations of whale sharks and vigilant surveillance for understanding the dynamics of interactions among tourist activities, fishing operations, and whale sharks.

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JUVENILE CORAL REEF FISH IN TROPICAL SHALLOW MACROPHYTE HABITATS (Abstract ID: 29456)

Landscape matrix and habitat differentiation are recognised to shape and impact coral reef fish communities. Densities and abundance of certain reef fish are shown to be linked to the presence or absence of adjacent nursery habitats, such as seagrass and mangroves. However, there is limited information on nursery functions of other macrophyte areas such as macroalgal beds. For successful management and conservation of the coastal zone it is important to identify key habitats for fish recruitment. We examined fish assemblages of macroalgal beds, seagrass meadows and a shallow coral reef, with emphasis on juvenile reef fish communities, in a shallow water bay in Zanzibar, Tanzania. Fish densities were determined by visual census in belt transects, where fish were identified and classified into age categories depending on length estimates. Juveniles generally dominated in macroalgal beds, whereas subadults were the dominating age category both in seagrass beds and the coral reef. Juveniles of coral reef associated species were significantly more abundant in seaweed beds than in seagrass meadows, as was species utilized by fisheries. Also interesting is that juveniles of Labridae and Scaridae were significantly smaller in macroalgal than in seagrass beds, indicating a role of algal beds as initial juvenile habitats for both coral and seagrass associated species. Our results indicate that juvenile fish use a range of different macrophyte habitats, and that macroalgal beds can be important recruitment grounds for coral reef fish species.

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INORGANIC CARBON UPTAKE AND PROCESSING FOR PHOTOSYNTHESIS IN THE CORAL-*SYMBIODINIUM* SYMBIOSIS: A QUANTITATIVE PICTURE (Abstract ID: 27895)

The process by which corals take up dissolved inorganic carbon (DIC) from the water column for photosynthesis by their *Symbiodinium* symbionts has long been described, but not fully quantified. However, in light of changing oceanic conditions, this quantitative description is essential to understanding potential alterations to the symbiosis. Using membrane inlet mass spectroscopy methods, we have directly quantified key aspects of DIC supply in three different coral taxa. By measuring $^{18}O$ isotope exchange rates, we de-

termined carbonic anhydrase (CA) activity in various areas of the coral and *Symbiodinium*. Activity levels are high both internally and externally in the coral, as well as within the *Symbiodinium*. Inhibiting external coral CA showed the relative equal contributions of $CO_2$ and $HCO_3$ to net photosynthetic production. All of this information was put into the context of photosynthetic requirements for corals and *Symbiodinium* to produce the overall, quantitative picture of DIC uptake and processing. The final description showed that, despite the ability of corals to efficiently concentrate more DIC than strictly necessary to support photosynthesis, the*Symbiodinium* were carbon scarce *in hospite*. This suggests the potential for the corals to regulate the flow of DIC to the *Symbiodinium*.

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COMPLEMENTARY MANAGEMENT PRACTICES TO ENHANCE FISH BIOMASS IN INDONESIA (Abstract ID: 28668)

Karimunjawa National Park (KNP) is a marine park in Indonesia, established in 1999 and rezoned in 2005. To examine the effects of the re-zoning, we examined the in situ biomass of reef fish from 2005-2013, and changes in fish catch landings from 2009-2014. We evaluated changes in reef fish populations and reef fish catch landings over time in no-take zones, in gear restriction zones and in control areas outside the park. Overall fish biomass decreased by more than 50% from 2005-2009, likely attributed to non-compliance within no-take zones. In 2009 measures to improve community compliance with fishing regulations included co-management enforcement operations and livelihood incentives. From 2005-2011 the percentage of local inhabitants that supported park regulations more than doubled. Reef fish biomass increased by more than 250% from 2009 to 2013, largely explained by increases in five trophic groups. Village laws afforded several Serranidae species additional protection through bans on some species, periodic closures and fishing gear restrictions. Since the measures were implemented, Caesionidae, Lutjanidae and Serranidae biomass increased by up to 200% until 2013. Handline and speargun catch per unit effort (CPUE) remained stable from 2009-2014, while the trap CPUE increased over this period. Interestingly both overall reef fish biomass and coral cover showed comparable increases at locations outside KNP, which suggests they also benefited from the bans on exploitative and destructive fishing in the Karimunjawa Islands.
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RESILIENT FISHERIES MANAGEMENT OUTCOMES: CASE STUDY ANALYSES FROM FOUR FIJIAN AND TORRES STRAIT COMMUNITIES (Abstract ID: 30145 | Poster ID: 588)

Adaptive co-management is an emerging approach to fisheries management which aims to create cross-scale, collaborative management strategies, that foster resilience in social-ecological systems.Adaptive fisheries co-management is relatively new to Australia where the fisheries have mostly been centrally or government-managed. Fiji has had a decade of experience in trialing and improving the process of adaptive fisheries co-management using a community-based approach as the starting point. However, the governance arrangements, social mechanisms and processes which create and sustain successful adaptive fisheries co-management are still under-investigated and often misunderstood. The observed livelihood benefits of adaptive fisheries co-management are also not fully understood, especially in wealthy communities and at the early stages of the adaptive fisheries co-management process. This study sought to measure the changes in the observed governance, social and livelihood benefits as adaptive fisheries co-management progresses in Australia and Fiji through four case studies. The study concluded that working towards a shared and delegated type of governance between government and communities built on trust, shared vision, shared knowledge and networking are critical to consider for a resilient fisheries management outcomes and sustainable livelihoods.

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NETWORKING SUPPORTS THE PROLIFERATION OF LOCALLY MANAGED MARINE AREAS (LMMAS) IN THE PACIFIC (Abstract ID: 30079)

Coastal communities worldwide are facing challenges to food security and are vulnerable to disasters and climate change impacts. Local marine management undertaken by communities has often achieved benefits that may have eluded top-down MPAs. In the Pacific, locally managed marine areas (LMMAs) have proliferated and a growing network of communities, managers and practitioners strengthened since 2000. The approaches are built on a unique feature of the region – customary tenure and resource access – and often making use of traditional knowledge and governance. LMMAs in the Pacific are implemented by over 600 communities spanning 17 independent countries and territories, representing a unique global achievement. Other examples also exist around the world. The spread and endurance of LMMAs is attributable to communities' perceptions that benefits are very likely to be achieved. The main innovation that has supported the proliferation of LMMAs is the operation of clusters of communities supported by regional, national and sub-national umbrellas or social networks. The regional LMMA Network includes Fiji, Solomon Islands, Papua New Guinea, Indonesia, Philippines, Palau and Federated States of Micronesia each of which have developed affiliated national and provincial sub-networks. Key success and challenges facing LMMAs and their supportive social networks are also discussed. In essence, LMMAs serve as building blocks for integrated island management and sustainable development by communities.
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GLOBAL PATTERNS OF INTRASPECIFIC LIFE-HISTORY VARIATION REVEAL HIERARCHICAL IMPORTANCE OF ENVIRONMENTAL DRIVERS IN WIDESPREAD CORAL REEF FISHES (Abstract ID: 27833)

Metabolic rate in ectotherms is largely dependent on the interaction between ambient temperature and body size; hence, there are predictable demographic trends within species that arise along latitudinal gradients across broad spatial scales, whereby largest body size and greatest life span are often achieved with decreasing temperature at higher latitudes. The past decade of coral reef fish research has highlighted many examples, however, of substantial variation in life-history traits at various spatial scales that are not correlated with temperature, but rather demonstrate the importance of factors such as density-dependent competition, predation, habitat variability, reef geomorphology, anthropogenic fishing pressure and primary productivity. We examined life-history variation across the entire range of the bullethead parrotfish (Chlorurus sordidus [Red Sea – Indian Ocean] and C. spilurus [Pacific]). Otolith-derived length-at-age profiles of populations from over 30 locations spanning from the Northern Red Sea to Moorea provided estimates of growth rate, lifespan, length at sex change, and asymptotic length, and constituted the most extensive investigation of intraspecific life-history variation in any coral reef fish to date. Our research demonstrates that while temperature and productivity gradients strongly influence life history, other drivers of variation are constrained by the observed spatial scale, which pervades as the underlying context from which significance can be assessed.
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EXTENDING SOUNDSCAPE SURVEYS OF CORAL REEFS USING AUTONOMOUS OCEAN GLIDERS (Abstract ID: 29674)

Autonomous ocean gliders are platforms advantageous for surveying large geographic regions to study bioacoustic and anthropogenic noise. Under a Navy Oceanographic Office and NOAA partnership, we deployed a Slocum ocean glider outfitted with a low-power, lightweight "Remora-ST" passive acoustic recorder attached to the exterior hull during a mission to characterize the oceanography and soundscape around the island

of St. Croix, US Virgin Islands during March 2015. The glider mission was designed to transit marine protected areas near Lang Bank, the shelf edge, and the southwest promontory of the island, locations in which groupers and snappers are thought to form spawning aggregations. Many species of grouper use sounds to communicate among conspecifics during spawning periods, but most spawning locations are poorly located or undescribed. During the glider mission, sounds from reef fishes, including squirrel fishes and sounds consistent with those made by groupers, were detected and traced to areas where spawning activity has been suspected near outlying reefs and promontories. We further discuss considerations for interpreting passive acoustic data from ocean gliders and propose expanded use of these autonomous platforms for extending the coverage of research of soundscapes in coral reef ecosystems.

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INTERACTIONS BETWEEN SEDIMENTS AND HERBIVOROUS FISHES ON CORAL REEFS (Abstract ID: 28513)

The epilithic algal matrix (EAM) is often the most widespread form of benthic cover on coral reefs. All EAMs trap sediments within the algal turfs. These sediments attract little attention, yet may be of critical importance in mediating benthic ecological processes, including herbivory. We quantified the loads and grain size distributions of EAM-based sediments, across broad spatial scales. Distinct differences in total loads and grain size distributions were revealed between biogeographic zones across the Great Barrier Reef. These patterns, of EAM sediment distribution, were then examined with regard to the influence of herbivorous fishes in shaping sediment dynamics. In some zones sediment production by parrotfishes may contribute substantially to EAM loads, as they produce sediments equivalent to the loads within EAMs in just three days. In other areas it would take parrotfishes three months to produce similar quantities of sediment. These broad scale patterns of sediment production and retention have the potential to mediate rates of herbivory across similar scales. Currently we do not know if the broad scale patterns of EAM sediment distribution are temporally stable, or how increased terrestrial sediment inputs may affect EAM loads. However, as EAM sediments are concealed within the algal turfs of the EAM, changes to EAM sediment loads may go unnoticed during standard reef monitoring, despite their potential for long term ecological consequences.

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QUANTIFYING THE MAGNITUDE OF SMALL-SCALE CORAL REEF FISHERIES IN THE CORAL TRIANGLE (Abstract ID: 27999 | Poster ID: 269)

Small-scale fisheries are crucial to the socio-economic livelihood of coastal communities in the Coral Triangle, but uncontrolled, have led to widespread coral reef degradation. The magnitude of catch taken from coral reefs is poorly reported and is a major barrier to informed management. We address this knowledge gap by estimating coral reef fish catches in the Coral Triangle from 1950 to 2010. The reconstruction supplements officially reported fisheries statistics with unreported catch amounts estimated from published and gray literature, as well as expert opinions. Our analysis suggests that coral reef fish catches are strongly underestimated in the Coral Triangle on the basis of under reporting in the small-scale subsistence and artisanal fisheries of six countries – Sabah (Malaysia), Philippines, Western Indonesia, Timor Leste, Papua New Guinea, and Solomon Islands. Reconstructed catches of the traditional sector in Sabah were 3.7 times higher than reported catches, while coastal subsistence and artisanal fisheries in Papua New Guinea were under-estimated by about 3 times. The reconstructed catch for Solomon Islands included 200,000 t of previously unreported subsistence catch, and in Timor Leste the dominance of subsistence fisheries was reflected in high composition of reef fishes in the reconstructed catch. Our study suggests that coral reef fish exploitation is much higher than official statistics indicate. These previously unquantified extractions must be considered when designing fisheries policies for ecosystem and human well-being in the Coral Triangle.

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ALDABRA ATOLL WORLD HERITAGE SITE – THE VISION OF A GENIUS OR A MADMAN? (Abstract ID: 29498)

In 1964, David Stoddart serendipitously learned of the British military's plans for expansion of its presence in the Indian Ocean while in a bar in the Maldives. Of particular note was the plan to turn Aldabra Atoll (Seychelles) into a Royal Air Force facility that would compromise its unique biodiversity, something he referred to as an "ecological disaster of the first magnitude". Upon returning to England and raising his concerns with the Royal Society and Ministry of Defence, Stoddart embarked on an expedition to Aldabra Atoll (1966) that would change his life forever, and set in motion a conservation movement on the value and importance of tropical marine protected areas. Within a few minutes of landing on Aldabra that first time Stoddart realised it "was one of the most remarkable islands on the earth" –which, coming from a man who had already been to the far corners of the planet, spoke volumes. The work of Stoddart, along with many others, led to Aldabra Atoll being inscribed as a World Heritage Site in 1982. Today Aldabra remains just as unique as it was when Stoddart landed there in 1966 although it has not been unscathed by the impacts of climate change that we see with increasing frequency. The UK Ministry of Defence branded Stoddart 'useless' but it was this 'useless scientist' that paved the way for modern ocean governance and marine protection on scales never imagined. This session will explore Stoddart's formidable work that led to Aldabra's protection for the benefit of humankind and his influence on the creation of vast tropical marine protected areas.

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UNDERSTANDING REEF FLAT SEDIMENT REGIMES AND HYDRODYNAMICS CAN INFORM EROSION MITIGATION ON LAND (Abstract ID: 28260)

The objectives of this work were to understand the role of coastal oceanic and biophysical processes in mediating the effects of sedimentation in shallow reef environments, and to assess the efficacy of land-based sediment remediation in the coastal areas near Maunalei reef, Lāna'i Island, Hawai'i. We developed ridge-to-reef monitoring systems at two paired stream bed-to-reef sites, where one of the reef sites was adjacent to a community stream sediment remediation project. The two reef sites had different sediment removal rates and were also exposed to different amounts of sediment runoff. The community stream sediment remediation project appeared to keep at least 77 tonnes of sediment off the reef flat in one wet season. We found that resuspension of sediments on this reef was similar to that on north-facing and south-facing reefs that also are exposed to the trade winds. We posit that sites with slower sediment removal rates due to slower current velocities or high resuspension rates will require more robust sediment capture systems on land to reduce sediment input rates and maximize potential for reef health recovery. This suggests that interventions such as local sediment remediation and watershed restoration may mitigate sediment delivery to coral reefs, but these interventions are more likely to be effective if they account for how adjacent coastal oceanographic processes distribute, accumulate, or advect sediment away from reefs. Our results on the effectiveness of gabion dam sediment capture may help guide scalable solutions for erosion control on islands.

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MONITORING AND EVALUATION OF CORAL TRANSPLANTATION TO MITIGATE DREDGING WORKS (Abstract ID: 28695)

To protect marine life from direct impact by dredging works for creating a port access channel in New Providence, Bahamas, over 1400 viable hard coral colonies and a broad range of associated invertebrates were relocated to recipients sites outside of the demarcated dredge and impact zone. Large coral boulders were transported using a multipurpose vessel equipped with a crane, smaller coral mounds and associated benthic invertebrates were relocated submerged with purpose-designed floating underwater cages. Most corals were transplanted to recipient sites that mimicked the donor sites in environmental conditions to enhance success rates, and a small sample was used to experiment with survival rates at significantly deeper waters, and with re-attachment to steel surfaces (ship wreck). Transplantation took place in February 2015 when environ-

mental conditions were optimal for maximum coral resilience. Monitoring was carried out 2, 8 and 26 weeks after transplantation to determine survival, growth, detachment, bleaching and predation of the coral colonies. One year after relocation a full growth and health status assessment has been executed. Preliminary data suggest survival rates in excess of 90% and excellent calcification rates. This paper evaluates the success of the coral transplantation program and presents best practices for future implementation as a mitigation measure in marine infrastructure development projects.

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GENETIC VARIATION IN TRAITS OF SYMBIODINIUM: POTENTIAL FOR EVOLUTIONARY RESCUE VIA SYMBIONT ADAPTATION (Abstract ID: 29841)

The breakdown in the mutualism between coral reef species and their algal symbionts (Symbiodinium) that occurs as a result of increasingly warmer ocean temperatures is a major threat to coral reefs around the globe. Species may respond to this rapid environmental change through either acclimatization or adaptation, but the long generation times of most host species may result in slow rates of adaptation. However, high rates of somatic mutation have resulted in significant genetic variation within Symbiodinium populations, which could provide the raw material for natural selection and adaptation to increased temperature on contemporary time scales. Such genetic variation, coupled with strong selection pressure and short generation times of symbionts (Symbiodinium) afford the potential for rapid evolution and adaptation of the symbiont population. We measured trait variation among genotypes within Symbiodinium antillogorgium. We found significant variation in traits that are likely to affect the strength of the mutualism with host species, including chlorophyll content, quantum yield, growth rate, and nitrogen use. Further, we exposed genotypes to ambient and elevated temperatures and found that genotypes varied in their trait and fitness responses to temperature, indicating a potential for selection on traits. Selection for particular genotypes may confer adaptation of the holobiont to increased temperatures on coral reefs and provide some hope for evolutionary rescue of reef species via adaptation of their symbionts.
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ILLEGAL HARVESTING AND TRADING OF BLACK CORALS (ANTIPATHARIA) IN MADAGASCAR: THE NECESSITY OF FIELD STUDIES (Abstract ID: 28610)

Black corals (Cnidaria: Antipatharia) have been used for medicinal purposes or in jewellery manufacturing since a long time in many parts of the world. Except in Hawaii where these fisheries are well known, black coral harvests are usually made without any control and management. This is the case in many tropical islands and particularly in Madagascar, where the illegal trade that exists since decades has expanded dangerously during the last years. Since 2011, an illegal traffic of black corals has been occurring in the main cities of the southern and coastal regions of the country. Hundreds of kilograms of black coral skeletons and a lot of diving material were seized by the authorities and efforts were made by scientists and politicians to stop this illegal trade. Despite this and the continual harvesting of these natural resources, there has been no study in the Indian Ocean region on the biology and ecology of antipatharians. Our research aims at studying black coral populations of the southwestern coast of Madagascar. Here, we explain the current black coral harvesting occurring in the country and present the first insights into the structure and biodiversity of a black coral meadow in Toliara. We identified 19 different morphotypes and described the skeleton spines, mesenteries structures and general morphologies. Due to the general difficulty to identify species among the Order Antipatharia, we also worked on ribosomal ITS regions to assess phylogenetic relationships among these black corals.

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A MODERN APPROACH FOR SPECIES DELIMITATION IN THE CORAL GENUS *GONIOPORA* (Abstract ID: 28652)

We investigated the species boundaries of the scleractinian coral genus *Goniopora* from several localities in the Indian and Pacific Ocean and from the Saudi Arabian Red Sea. We used an integrated morpho-molecular approach to better clarify the complex scenario derived from traditional classification efforts based on skeletal morphology. Molecular analyses of evolutionary relationships between different traditional morpho-species of *Goniopora* were performed to re-evaluate the informativeness of macromorphological and micromorphological features. Several lineages were molecularly resolved within *Goniopora* samples on the basis of four molecular markers: the mitochondrial intergenic spacer between Cytochrome b and the NADH dehydrogenase subunit 2, the entire nuclear ribosomal internal transcribed spacer region, the ATP synthase subunit β gene, and a portion of the Calmodulin gene. DNA sequence data were analyzed under a variety of methods and exploratory species-delimitation tools. Subsequent analyses of micromorphological and microstructural skeletal features identified the presence of distinctive characters in each of the molecular clades. Unique *in vivo* morphologies were associated with the genetic-delimited lineages, further supporting the molecular findings. Some colonies show a peculiar genetic pattern that could indicate hybridization. The proposed re-organization of *Goniopora* will resolve several taxonomic problems in this genus while reconciling molecular and morphological evidence.

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*SYMBIODINIUM* DISTRIBUTION ALONG THE SOUTHWESTERN ATLANTIC COAST (Abstract ID: 29462 | Poster ID: 126)

The Brazilian coast has the only true shallow water coral reefs of the Southwestern Atlantic Ocean. However, coral-Symbiodinium relationship patterns are still poorly understood in this area. In order to assess these patterns, the diversity and distribution of Symbiodinium were sampled in 2 corals, 1 hydrocoral and 1 zoanthid species at 5-15 locations along the Brazilian coast. Symbiodinium strains were assessed by 18S and 28S rDNA PCR/RFLP analyses and ITS2 cloning and sequencing. The symbiosis patterns seem to be driven more by host identity than by environmental variations. Palythoa caribaeorum had a specific association with Symbiodinium clade C (C1/C3) along the whole coast. Favia gravida was dominated by clade C (C1/C3), except at Rocas Atoll, where it was associated with clade A. Mussismilia hispida and Millepora alcicornis were quite generalist, harboring clades A, B (B1, B30, B39) and C (C1/C3) with different association patterns along the coast. In both species, colonies from the central Brazilian coast (Bahia State) hosted different symbiont communities from those observed at all others locations. High sedimentation rates coupled with its seasonal variability could explain this unique pattern. A latitudinal pattern was also observed, with upwelling events favoring the mixture of clades in M. hispida and the presence of a new Symbiodinium strain (B39), associated with M. alcicornis. Our results represent the first major investigation of Symbiodinium diversity along the Southwestern Atlantic and are relevant for future studies and conservation strategies.

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THE CONTRIBUTION OF LARGE DECAPODS TO MAINTENANCE OF CORAL REEF COMMUNITY INTEGRITY (Abstract ID: 29543 | Poster ID: 285)

Overexploitation and habitat loss have resulted in declining marine capture fisheries worldwide even as our general understanding of the ecosystem consequences of such changes lags behind. There is now a general recognition that chronic overexploitation can alter living communities which may no longer facilitate previous levels of fisheries harvest and other critical ecosystem services. Despite the significance of large decapod fisheries around the world and a number of studies illustrating decapod top-down control in temperate systems (e.g. kelp beds) the ecological role of large decapods in maintaining tropical coral reef integrity and resilience is relatively poorly understood. Beyond the impact on lobster populations and loss of income to fisheries dependent households, the overexploitation of Caribbean Spiny lobster may have disproportionally high levels of impact on coral reef health and resilience given their naturally high abundance and involvement in a diverse set of trophic interactions. A number of other

large coral reef dwelling decapods (e.g. Caribbean King crab Mithrax spinosissimus ) are also involved in complex trophic dynamics within coral reef ecosystems. As such, can the abundance and population structure of large decapods on coral reefs, influenced by fishing on reefs and possibly use of artificial structures in other habitats, be significantly correlated with metrics of coral reef community integrity and be useful indicators of the past, present and future state of coral reefs?
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OCEANIC FARMED FLORIDA ACROPORA CERVICORNIS: SPAWNING, VIABILITY, TRANSPORTING AND SETTLING IN LAND-BASED AQUACULTURE FACILITIES AS A RESTORATION STRATEGY (Abstract ID: 29668 | Poster ID: 558)

Land-based aquaculture of endangered coral species has been identified as a significant potential strategy for coral restoration efforts, warranting more work in this area. The Florida Aquarium has been participating in the natural coral spawn of Acropora cervicornis in the Florida Keys since 2010. Working closely with the Coral Restoration Foundation and University of Florida, after several years of failure refining techniques and timing, this collaboration has successfully captured gametes in the field, fertilized them in the laboratory, and transported the product long distances to research facilities in central Florida for settling for the last 3 years. In 2014 and 2015 we collected 280K and 520K bundles, respectively using modified cone nets over 2-3 nights each season. In 2015, we calculated 67% (350K/520K) viability. Post fertilization, samples were packed at a density of 5000 larvae/1L, in 1L plastic bottles using supersaturated system water while being maintained at 24°C for up to an 8 hour journey by road to our research facilities. Multiple techniques have been used in an attempt to settle the larvae, which is proving an ongoing bottleneck. Substrate, water flow, feeding regimes, tanks size and shape and husbandry have all been examined. To date, the most promising approach has been the use of seasoned tiles with adult corals in situ to provide zooxanthellae. All other variables have produced mixed results. Success rates are still below those that could be of use to mass restoration using land-based aquacultured corals to our imperiled reefs.

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PLACE-BASED OPERATIONALIZATION OF THE SOCIAL-ECOLOGICAL VULNERABILITY FRAMEWORK TO FOSTER SOCIAL-ECOLOGICAL RESILIENCE (Abstract ID: 28191)

Human-environment interactions, including feedbacks, are now explicitly considered in social-ecological system conceptual frameworks. However, there is a crucial need to develop case-specific operationalization of such frameworks to inform place-based management. The social-ecological vulnerability assessment framework - that incorporates sensitivity, adaptive capacity and exposure of both socio-economic and ecological sub-systems to change or stressors - holds great promise to be an effective tool for conducting systematic, coupled-system analysis. To date, much effort has been dedicated to model and assess social-ecological vulnerability to climate change. Here, we have adapted and tested this framework on the reef fisheries of Moorea, French Polynesia, to identify the local ecological, socio-economical and cultural processes supporting potential for social-ecological sustainability. Our key contributions to social-ecological frameworks are: 1) the development of a novel, mixed approach to map each dimension of vulnerability at the system-level; and 2) the explicit consideration of reciprocity and feedbacks between the social and ecological vulnerabilities. Our results show that key sources of vulnerability differ considerably between locations on the island, providing important insights into the types and design of policy interventions that may help to reconcile conflicting conservation and socio-economic objectives in this developing island.

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ROLE OF SEA URCHIN CENTROSTEPHANUS TENUISPINUS (CLARK, 1914) AS A BIO-ERODER- IN HALL BANK REEF (32 2.002◦S AND 115 42.957◦E) WESTERN AUSTRALIA (Abstract ID: 28715)

Among many reefs in Western Australia, Hall Bank reef is unique in its geographical position (closer to the 20°C isotherm), nearshore location, presence of higher hard coral cover and absence of macroalgae. Sea urchins play a key role in many benthic marine habitats as grazers and bioeroders and hence, are considered as reef engineers. Due to their strategic position in marine food webs as grazers, they can have a drastic impact on their habitat. Thus, presence of sea urchins in high densities is thought be the reason behind the absence of macro algae on Hall bank reef.This study focused on evaluating the role sea urchins, Centrostephanus tenuispinus, on Hallbank reef. Gut contents of 78 urchins were analysed for organic and inorganic components during winter 2015. CaCO3 ingestion rates were calculated. Fifty urchins were kept in sea water flow through aquarium. Five urchins were dissected at time intervals 0, 4, 8, 16, 24, 36, 48, 60, 72 and 96 hr to estimate the gut evacuation rate. Five under water cages (6 urchins/cage) were maintained in the adjacent sea grass bed to estimate the correction factor for newly eroded CaCO3 experiment. Urchin densities were estimated using ten haphazardly laid belt transects (20m X 0.5m). Mean sea urchin density in winter was 5.26±1.25. Mean percentages for organic gut contents, calcium carbonate and other siliceous inorganic components were 8.83±0.23%, 86.96±0.43% and 4.25±0.34% respectively. Daily gut turnover rate was 0.24 day-1. Newly eroded CaCO3 percentage was 20.3 %. Food ingestion rate was 1.23±0.46 (gut dry weight individual-1 day-1). Bio-erosion rate for winter was 0.36±0.13 g CaCO3 individual-1 day-1.

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CURRENT STATUS AND THE EFFECT OF SHADING ON PROGRESSION OF THE CORAL KILLING SPONGE (TERPIOS HOSHINOTA) ON THE REEFS OF PALK BAY, INDIA (Abstract ID: 29012 | Poster ID: 220)

Terpios sponge outbreaks cause significant decline in living coral cover and recently Terpios has been reported on reefs in Palk Bay located on the southeast coast of India. However, no information was available on its progression across corals and the rate of spread in the affected area. In this study, we investigated the progression and the rate of spread of Terpios over live coral colonies, and potential variation in progression rate between species. The effect of light on the progression of sponges over live corals was examined by conducting in situ shading experiments for a 6 month period. The presence of T. hoshinota in our study site was confirmed via molecular analysis. Surveys along belt transects revealed that, all observed coral genera (Symphylia, Porites, Acropora, Platygyra, Favia and Favites) and other non coral organisms including coralline algae were found to be covered by this sponge. The proportion of colonies affected by the sponge (prevalence) increased from 24% to 33% within a 6 month period. An average progression rate of 2 cm/month over live coral colonies was observed irrespective of species. Shading stoped sponge progression without any apparent affect on the shaded live coral portion. This preliminary study suggests that Terpios sponge is spreading within Palk Bay reef and the shading method may reduce the impact of the sponge on coral. Studies are needed to further develop and test the shading as a method of sponge control to reduce the sponge's impact on the coral reef ecosystem.

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A LONG ROAD TO RECOVERY: USING RNA-SEQ TO UNDERSTAND THE CORAL STRESS RESPONSE TO NATURAL BLEACHING EVENTS (Abstract ID: 28792)

Rising global temperatures are a major threat to coral reefs worldwide, and the increasing frequency of regional bleaching events poses serious challenges to the maintenance of healthy coral reef systems. While transcriptome-wide gene expression analyses (e.g. via RNA-seq) have greatly improved our understanding of coral responses to heat stress, most work to date has focused on the responses of corals to experimental heat stress in a controlled environment and there remains a lack of in situ field expression data from natural bleaching events. In this study, we use a combination of RNA-seq, co-expression analyses, and guava flow cytometry to examine the coral stress response to a warm-water event that struck American Samoa in early 2015. We incorporate information from acute experimental heat stress and sub-bleaching field stress data to focus our analyses on groups of co-expressed genes (transcriptional modules) that are responsive to heat stress, allowing us to examine both the magnitude and duration of the stress response mounted by corals during natural bleaching events. Transcriptional modules previously associated with experimentally-induced bleaching and sub-bleaching field stress also increased during the natural bleaching event. Interestingly, the response of these modules was greatest four months after bleaching was observed, despite colonies showing visual signs of recovery and symbiont densities returning to normal levels. These results suggest that the physiological stress response mounted by corals to warm-water events lasts for several months, well after corals have regained pigmentation.

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ASSESSING AND COMMUNICATING THE STATUS OF CORAL COMMUNITIES USING A CONDITION INDEX BASED ON MULTIPLE INDICATORS RELEVANT TO WATER QUALITY (Abstract ID: 28092)

A critical component of environmental decision making process is the regular assessment of environmental condition against which to gauge the success, or otherwise, of management actions. Condition of coral reefs is influenced by multiple pressures, making it difficult to isolate individual stressors or responses of importance. Using, as an example, coral monitoring associated with the Reef Water Quality Protection Plan (RWQPP) for the Great Barrier Reef World Heritage Area (GBR), we report the development of an multi-indicator index of coral community condition. Index formulation included selection of indicators that were: relevant to pressures associated with runoff, responsive on the time scale (years) of likely outcomes of the RWQPP, and able to be efficiently monitored across the scale (100's of km) of the program. Thresholds were set that allowed the state of each indicator to be scaled along a condition gradient, and then aggregated into an overall index score with associated uncertainty estimates. Trends in the index yielded a demonstrable relationship to loads of contaminants entering the GBR in runoff. Several consecutive years of high annual rainfall resulted in increased runoff from the GBR catchments and a concurrent decline in index scores. A return to more moderate rainfall saw a decline in runoff and some improvement in the index scores. The sensitivity of the index to the cumulative impacts affecting reefs exposed to runoff emphasizes its utility as a cost-effective condition assessment and reporting tool to inform the environmental decision making process.

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VARIABILITY IN REEF CONNECTIVITY IN THE CORAL TRIANGLE (Abstract ID: 29558)

Larval connectivity plays as critical role in maintaining viable coral populations; however, the variability in larval dispersal over decadal timescales is poorly understood. We examine variability in reef connectivity in the Coral Triangle following April and September spawning over a nearly 50-year period (1960-2006) using a 5-km resolution Regional Ocean Modeling System developed for the Coral Triangle (CT-ROMS) and a Lagrangian particle-tracking tool (TRACMASS). We found that potential connectivity in the CT is highly variable, emphasizing the importance of simulations that are at least 20 years long for identifying connectivity patterns and thus management targets. This connectivity variability is driven primarily by stochasticity in surface currents, though the impacts of ENSO and the IOD on the South Equatorial Current also play an important role. Although mean potential connectivity over the 47-year simulation suggests that reefs in this region are primarily self-seeded, exceptions highlight important source and sink regions and pathways for recovery following disturbance. The spatial pattern of "subpopulations" based solely on the physical drivers of connectivity between reefs closely match major phylogenetic lines and regional patterns of biodiversity, suggesting that physical barriers to larval dispersal may be a key driver of reef biodiversity. 21st Century simulations driven by the Community Earth System Model RCP8.5 scenario suggest that these major barriers to larval dispersal persist into the future, despite some regional changes in reef connectivity.

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REMOTE SPECTROSCOPIC RETRIEVAL OF APPARENT OPTICAL PROPERTIES AND BOTTOM REFLECTANCE IN SHALLOW CORAL ECOSYSTEMS (Abstract ID: 29573)

Remote spectroscopy in the 400-800 nm range can observe reflected light from shallow water benthic environments, simultaneously characterizing water properties and bottom composition. Specifically, airborne mapping spectrometers such as NASA's Portable Remote Imaging SpectroMeter (PRISM) are powerful tools to map coral reefs over wide areas. However, such inversions are difficult due to the intrinsic ambiguity in separating bottom reflectance, depth, and water optical properties, which leads to non-unique retrievals. While many retrieval algorithms have been developed, true operational spectroscopic mapping of coral reefs remains elusive. This work describes a method for accurate and stable bottom reflectance retrieval at speeds suitable for large remote sensing datasets, such as those of the forthcoming COral Reef Airborne Laboratory (CORAL) investigation. We capture water constituents using two apparent optical properties (AOPs): backscatter, and the "operational" attenuation term of Maritorena et al. (1994). These coefficients, along with depth, glint, and bottom reflectance, define a simple model for subsurface irradiance reflectance. Both AOPs and bottom reflectance use a nonnegative mixture representation, a subspace of variability based on a library of endmembers drawn from simulated or field data. We evaluate the approach by mapping Eelgrass and sediment in the Elkhorn Slough, and coral reef communities in the Florida Keys. The method provides stable results that are consistent with field validation, presaging its utility for mapping coral reefs over wide areas.

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DO CORALS ADAPT THEIR ANNUAL SYMBIOTIC METABOLISM STRATEGIES TO COPE WITH SEASONAL TEMPERATURE STRESS AND NITROGEN POLLUTION? (Abstract ID: 29298)

Rising global sea temperatures and localized eutrophication threaten the integrity of the coral-algal symbioses in coastal reef communities. The propensity to adapt host-symbiont metabolic interactions during periods of warming may mediate negative effects to their overall physiology, such as bleaching. Coral species vary in their capacity for heterotrophy which, for corals, relies on passive suspension feeding. This study examines five coral species in Hong Kong (*Acropora digitifera*, *Montipora peltiformis*, *Galaxea fascicularis*, *Oulastrea crispata*, and *Porites lobata*) and explores changes in their metabolic strategies from autotrophy to heterotrophy, and vice versa, in accordance with seasonal temperature extremes as an adaptation to cope with unprecedented nitrogen pollution. We monitored host lipid content, *in hospite Symbiodinium* photochemistry using PAM flourometry, and photosynthesis/respiration (P/R) of the holobiont every month from August 2015 until the present. We have found that during colder, winter months (December/January) *A. digitifera* and *G. fascicularis* exhibited higher P/R ratios and greater photochemical efficiency, whereas *P. lobata* showed no change. These data indicate that some species are adapting their metabolic strategies according to seasonal temperature changes. This adaptation may offset the burden *Symbiodinium* imposes under conditions of high, localized nitrogen pollution during warmer, summer months (July/August/September).

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SURF AND TURF; PHYSICAL STRUCTURING OF BENTHIC COMMUNITIES AT NINGALOO REEF, WESTERN AUSTRALIA (Abstract ID: 28491)

Physical forcing, such as wave energy, plays a major role in the physical erosion of carbonate material and subsequently the structuring of coral reef communities. Extreme wave energy can reduce coral cover and alter community composition by favouring the most mechanically tolerant hard coral growth forms and low-profile macro algae, turfs and crustose coralline algae. Extreme wave energy can also reduce three dimensional complexity of the reef; when the rate of carbonate removal exceeds that of production. At Ningaloo Reef in Western Australia, wave energy is likely to be an important structuring force on the reef slope because (i) the reef is located adjacent to an extremely narrow section of the continental shelf (therefore wave generated energy gradients are steep); (ii) the reef is afforded no protection from large waves by nearby islands or continents; and (iii) it is located at a latitude where severe cyclones are frequent. Here, we present results from the first year of the Ningaloo Outlook shallow reefs project; a five year collaboration between BHP Billiton and CSIRO. Using the historical meteorological record, a high resolution wave model and photo mosaics of the seafloor, we predict some demographic consequences for coral reef communities growing on the Ningaloo reef slope. We also discuss the implications for community structure and carbonate budgets within these high energy environments.

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TRACING CABON FLOW THROUGH CORAL REEF FOOD WEBS USING A COMPOUND-SPECIFIC STABLE ISOTOPE APPROACH (Abstract ID: 29479)

Coral reefs support spectacularly productive and diverse communities in tropical and sub-tropical waters throughout the world's oceans. Debate continues, however, on the degree to which reef biomass is supported by water column or benthic primary production and recycled detrital carbon. We coupled analyses of stable carbon isotopes in essential amino acids with Bayesian mixing models to quantify carbon flow from pelagic primary producers, benthic macroalgae and autotrophic symbionts in corals, along with detrital carbon, to coral reef fishes across several feeding guilds and trophic positions, including apex predators (gray reef and black tip reef sharks), on reefs in the Phoenix Islands Protected Area in the central tropical Pacific. Excellent separation in multivariate isotope space among end-members at the base of the food web allowed us to quantify the relative proportion of carbon produced by each of the end-members that is assimilated by focal reef fish species. Low local human impacts on the study reefs provided the opportunity to examine carbon fluxes in fully functioning reef food webs, thereby providing an important baseline for examining human impacts in food webs on stressed reefs in more populated regions in the tropics. The study reefs are located along a significant gradient in dissolved N concentrations, allowing us to test if end-member proportions vary as a function of pelagic primary productivity levels. Our work provides insights into the roles that diverse carbon sources may play in the structure, function and resilience of coral reef ecosystems.

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POPULATION DENSITY OF CROWN OF THORNS STARFISH IN DIVE SITES OF THAILAND (Abstract ID: 28669 | Poster ID: 676)

The crown-of-thorns starfish (*Acanthaster planci*) is one of the major threats of coral reef degradation worldwide, especially in the Indo-Pacific region. Two principal hypotheses that account for starfish outbreaks are predator removal and terrestrial runoff. Tour boat operations, diving expeditions, eco-tourism and other tourist attractions based on reef environments are all at risk of economic loss due to damage caused by the coral-feeding starfish. This study aimed to investigate distribution and abundance of *A. planci* at 67 dive sites in the Gulf of Thailand and the Andaman Sea during 2013 – 2015. The surveys illustrated that the occurrence of *A. planci* in dive sites of Thailand, both in the Gulf of Thailand and the Andaman Sea, was not significantly different. Among the 67 dive sites, only two dive sites were categorized as abundance, i.e. Ko Ngam Yai, Mu Ko Chumphon, the Western Gulf of Thailand and Ao Losama, Mu Ko Phi Phi, the Andaman Sea. Three dive sites were classified as common while eight dive sites were categorized as rare. The population densities of *A. planci* from this study, except at Ko Ngam Yai and Ao Losama, are still much lower than that causes the outbreaks in other regions. The severe destruction of coral communities in Thailand caused by *A. planci* was not clearly recorded during the last three decades. This study contributes the important background information for establishing the management strategies to prevent the outbreaks of *A. planci* in dive sites of Thailand.

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ENGAGING RESOURCE USERS TO IDENTIFY SOCIAL AND ECOLOGICAL CHANGES IN AUSTRALIA'S CORAL TROUT FISHERY. (Abstract ID: 28463)

Resource users provide valuable information on marine ecosystem change, but their observations and perceptions of change may differ from other sources of available monitoring data. This creates potential for conflict and may reduce the legitimacy of management measures in the eyes of resource users. Coral trout is targeted throughout the Asia-Pacific for the live finfish trade, and this market forms an economically significant fishery in Queensland, Australia. While monitoring occurs in the Queensland fishery, detailed data have only been collected over the last few decades. Through interviews with 120 commercial and recreational coral trout fishers, we assessed ecological and social changes in Queensland's coral trout fishery across a period of 60 years to inform baseline conditions and to highlight areas of contention and agreement between scientific data and resource user observations. The majority of resource users observed declines in catch rate of coral trout. These declines began several decades prior to the commencement of scientific monitoring. Recent trends in recalled catch rates corresponded to aspects of fisheries landing trends, but contrasted with ecological data. Resource users also provided information on the impact of management measures on the fishery. Our findings suggest that data from resource users can be useful for closing gaps in knowledge of long-term trends, in addition to informing fisheries management of the social and cultural context in which resource users operate, including which aspects of assessment may be contentious with resource users.

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MICROHABITAT USE OF JUVENILE CORAL REEF FISH IN BOLINAO-ANDA REEF COMPLEX (BARC) (Abstract ID: 29113)

In a pristine reef environment, abundance of early juvenile reef fish is simultaneously determined by microhabitat structure and resident predator size. However, for disturbed reef environments, very little is known on the strength of this association. In this study, we quantified the structural differences among dominant microhabitats in a long exploited reef in the Philippines and determined the degree of association among microhabitat types and juvenile reef fish. The influence of foraging space, predator size and confamilial attraction on the abundance of juvenile pomacentrids was also determined to elucidate crucial post-settlement interactions. The results showed strong similarities in juvenile reef fish communities across different habitat types investigated. The abundance of herbivorous, egg brooding damselfishes across microhabitat types strongly influenced the overall similarities observed in juvenile reef fish assemblage. In general, juvenile pomacentrids settled more in areas with relatively small foraging space and in the presence of adult members of their family. The observed heterospecific grouping, especially in large numbers, enhances concealment of the smaller juveniles from predators, especially in circumstances where the environment does not provide much cover. This is seen as a strategy to minimize predation in a low complexity, predator accessible environment. Furthermore, the results also provide compelling evidence that the continued degradation of coral reef microhabitats strongly impact its associated reef fish community structure.
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ASSESSING THE FUNCTIONAL DIVERSITY OF REEF FISH HERBIVORES (AND DETRITIVORES?) USING A COMPOUND-SPECIFIC STABLE ISOTOPE APPROACH (Abstract ID: 28844 | Poster ID: 513)

Tropical coral reefs around the world are known to support a wide diversity and abundance of herbivorous reef fishes. These fishes play a key role in helping to maintain healthy reef ecosystems by clearing algae and creating space for corals to settle. The term herbivore however, includes a wide variety of species with different feeding methods, including browsing, excavating, grazing, and scraping, which all may help these fishes specialize their diets to specific plants, (epilithic) algae, or other components of the detrital pool. We use compound-specific stable isotope analysis (CSIA) paired with Bayesian mixing models to compare the functional dietary diversity of herbivorous reef fishes. We compare the isotopic signatures of &delta$^{13}$C values in fish tissue, fish foreguts, and dietary end members across acanthurids, scarids, and other fishes with dietary end members represented by brown, green, red, and epilithic algae groups. CSIA mixing model results and diet diversity will be discussed in the context of niche partitioning on coral reefs. The partitioning of herbivorous reef fishes into multiple food niches may help explain why such a high diversity and abundance of herbivorous fish species are found on some reefs, despite outwardly appearing to feed on the same food source.
http://CSIA_herbivorous_reef_fishes_diet

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HAWAI`I'S CLIMATE IN 2050 CE (Abstract ID: 28406)

This presentation will provide an overview of the projected large-scale changes of Pacific surface temperature, wind systems, sea level and ocean biogeochemistry over the next 35 years. Regional-scale projections for the Hawaiian Islands will be discussed

along with uncertainties stemming from modeling biases, unresolved physics, socio-economic decisions and natural variability.

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EXPLORING ENVIRONMENTAL AND GEOGRAPHIC PATTERNS OF CORAL REEF CRYPTOFAUNA COMMUNITIES (Abstract ID: 28725)

One of the most fundamental questions in ecology concerns the drivers of community assembly, i.e. the relative roles of abiotic and biotic factors in determining species' distributions and abundances. Here we examine motile marine invertebrate cryptofauna communities captured within Autonomous Reef Monitoring Structures deployed across Pacific Islands. Using raw data and distance-based approaches of beta-diversity, we examine to what extent environmental factors, such as nutrients, temperature and coral cover, and geographical location explain variation in community organization. Through variance partitioning and the "decay of similarity with distance", we investigate whether the environment or geography have a greater influence in observed cryptofauna composition. Observations on species occurrence, diversity, and abundance, together with environmental correlates, are starting points to understanding the distributions and community organization of reef cryptofauna. Further analyses on historical biogeography and evolution will need to additionally take place in order to better understand the mechanisms that may have shaped these communities.

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UNDERSTANDING CORAL'S SHORT-TERM ADAPTIVE ABILITY TO WATER POLLUTION USING GENETICS AND PROTEOMICS (Abstract ID: 28208)

Corals in Maunalua Bay, Hawaii are under chronic pressure from sedimentation and terrestrial runoff containing multiple toxicants as a result of large-scale urbanization that has taken place in the last 100 years. However, some individual corals thrive despite the prolonged exposure to these environmental stressors, which suggests that these individuals may have adapted to withstand such stressors. The lobe coral Porites lobata from the 'high-stress' nearshore site had an elevated level of stress induced proteins, compared to those from the 'low-stress,' less polluted offshore site, and genetic analysis revealed clear genetic differentiation between corals at the two sites, which are less than 2 km. To understand whether selection is driving the observed differentiation, a 30-day reciprocal transplant experiment was conducted. Protein expression profiles, as well as other stress-related physiological characteristics were compared in corals between the sites. The results suggest that the nearshore genotype can cope better with sedimentation and pollution than the offshore genotype, which indicates that the observed genetic differentiation is due to selection for tolerance to these environmental stressors. Understanding the little-known, linage-scale genetic variation in corals offers critical insight into their short-term adaptive ability, which is indispensable for protecting corals from impending environmental stressors and climate change.

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COMPARATIVE PHYLOGEOGRAPHY IN A MULTI-LEVEL SEA ANEMONE SYMBIOSIS: EFFECTS OF HOST SPECIFICTY ON PATTERNS OF CO-DIVERSIFICATION AND GENETIC DIVERSITY (Abstract ID: 28182)

Specialist and generalist life histories are expected to result in contrasting levels of genetic diversity at the population level, yet symbioses are expected to lead to patterns that reflect a shared biogeographic history and co-diversification. We test these assumptions using a comparative phylogeographic approach for six co-occurring crustacean species that are symbiotic with sea anemones on western Atlantic coral reefs, yet vary in their host specificities. We first conducted species discovery analyses to delimit cryptic lineages, followed by classic population genetic diversity analyses for each delimited taxa. The demographic history for each taxon was reconstructed using traditional summary statistics, Bayesian Skyline Plots, and approximate Bayesian computation to test for signatures of recent and concerted population expansion. The genetic diversity values recovered here contravene the expectations of the specialist-generalist variation hypothesis and classic population genetics theory: all specialist lineages had greater genetic diversity than generalists. Demographic reconstruction recovered evidence of recent population expansions using summary statistics, yet Bayesian skyline plots and approximate Bayesian computation suggest the timing and magnitude of these events were idiosyncratic. These results do not meet the a priori expectation of concordance among symbiotic taxa and suggests that the intrinsic aspects of species biology may contribute more to the phylogeographic histories of each taxon than extrinsic forces that shape whole communities.
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SYMBIOSIS AND NUTRITIONAL STATE ALTER THE CNIDARIAN CELL CYCLE IN THE SYMBIOTIC ANEMONE *AIPTASIA* SP. (Abstract ID: 29814)

The cnidarian-dinoflagellate endosymbiosis relies on the cellular coordination of its two partners, algal symbionts and the host cnidarian cells that contain them. We examined the effect of nutritional status and symbiotic state on host cell proliferation in the sea anemone *Aiptasia* sp., and its resident algal symbionts *Symbiodinium* clade B1, a model system for coral-dinoflagellate symbiosis. Anemones under three different symbiotic conditions: symbiotic, aposymbiotic (without symbionts) and colonizing (aposymbiotic animals being re-colonized with algae) were labeled with S-phase marker ethynyl deoxyuridine (EdU), G2/M-phase marker histone H3pSer10, and Hoechst dye. In symbiotic anemones, host DNA replication and cell division was lowest at night and significantly peaked in the afternoon. Symbiotic state and nutritional status had a strong interaction effect; starvation significantly increased replication and division rates in aposymbiotic anemones but decreased rates in symbiotic anemones. Gastrodermal tissue of starved aposymbiotic animals had significantly higher replication and division rates than the gastrodermis of symbiotic and fed aposymbiotic animals. We also examined division rates during onset of symbiosis. There were no significant rate changes between nutritional states, and rates appeared similar to those of aposymbiotic groups. Starvation also had a positive effect on symbiont proliferation. Our results suggest that host cell cycle and proliferation respond to long-term environmental change and symbiont state.

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ARE SEA FAN SCLERITES THE FIRST LINE OF DEFENSE AGAINST PATHOGENS? (Abstract ID: 29507 | Poster ID: 135)

Sessile organisms such as octocorals cannot avoid threats such as predation, parasitism or fungal infections through evasive responses. Instead, they relay on strategies that deter or reduce the impact of these threats. One such strategy is the development of anatomical structure known as sclerites, which are minute calcium carbonate structures laying on top of the ectoderm and within the mesoglea and gastrodermal tube walls. Sclerites have multiple roles, including structural support of the colony and predator deterring. However, the role of sclerites as a physical barrier that deters fungal infection is yet to be studied. In this study, we examine the potential role of sea fan sclerites as protection from fungal infection. To accomplish this, we inoculated four different fungi isolated from healthy sea fans into 5ml pipettes filled with culture media and on top of it sclerites from healthy and diseased fans. To determine whether chemical compounds associated with the sclerites impact infection, sclerites from healthy and diseased fans were extracted for several days with acetone prior to inoculation. Results showed that the sclerite layer delayed fungal infection of the agar when compared to controls (pipettes with agar but no sclerites). There were no difference between pipettes with healthy and diseased sclerites, but there were differences among sclerites extracted with acetone. This study indicates that, in addition to the structural support and predator deterring roles, sclerites may also play a role as physical and chemical barriers to fungal infection.

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TEMPERATURE SHUFFLES CORAL-ALGAL SYMBIOSIS IN THE SOUTH CHINA SEA (Abstract ID: 30046 | Poster ID: 132)

With sea surface temperature (SST) increasing, scleractinian corals are exposed to bleaching threats but may possess certain flexibilities in terms of their associations with symbiotic algae. Previous studies have shown a close symbiosis between corals and Symbiodinium; however, the spatial variation of the symbiosis and the attribution underlying are not well understood. In the present study, we examined coral-algal symbiosis in Galaxea fascicularis and Montipora spp. from three biogeographic regions across ~10° of latitude in the South China Sea. Analysis of similarities (ANOSIM) indicated a highly flexible coral-algal symbiosis n both G. fascicularis and Montipora spp. at the subclade level and redundancy analysis (RDA) using subclade data suggested that temperature was the main factor contributing to the diversity of Symbiodinium across three regions. The geographic specificity of the Symbiodinium phylogeny was identified, revealing possible environmental selection across the three regions. In addition, Symbiodinium ITS2

sequences derived from congeneric corals were more likely clustered together, revealing a correlated coral-algal evolution. In conclusion, our study demonstrated that coral-algal symbiosis was highly flexible in both G. fascicularis and Montipora spp., and temperature served as a major factor shuffling coral-algal symbiosis in congeneric scleractinian corals. These results suggest that scleractinian corals may have the ability to regulate Symbiodinium community structures under different temperatures and thus be able to adapt to gradual climate change.

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## WINNERS AND LOSERS OF CYCLONES AND BLEACHING: BENTHIC COMMUNITY CHANGES AFTER MULTIPLE DISTURBANCES (Abstract ID: 28022)

Climate change poses two main challenges for reef building corals: an increment in the frequency and severity of tropical storms; and ever increasing water temperatures. The differential susceptibility of coral species to these disturbances means that the affected coral assemblages temporarily or permanently reconfigure following such disturbances. To adapt management to the altered ecosystems, we need to better understand how coral assemblages change and for how long these changes are likely to persist. In this study I document the effect of a category 5 tropical cyclone and a subsequent thermal bleaching event on an inshore fringing reef of the Great Barrier Reef. Further to the transition from branching to massive/encrusting dominance in coral assemblages immediately following the cyclone, and the differences in bleaching mortality among coral taxa, I show evidence for the density dependence of the recruitment of brooding corals in the aftermath of the disturbance. I also present a novel method for rapid reef mapping using geotagging of coral colonies and custom made GIS scripts.

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## CHARACTERIZING SYMBIODINIUM DIVERSITY IN CANDIDATE RESILIENT CORAL SPECIES (Abstract ID: 29049 | Poster ID: 123)

Identifying resilient coral species and understanding determinants underlying resilience have important implications for coral reef restoration efforts. A key factor contributing to coral resilience is its obligate symbiotic relationship with photosynthetic single-celled dinoflagellates (zooxanthellae) predominantly belonging to the genus *Symbiodinium*. Zooxanthellae composition has been shown to be associated with coral survival in adverse environmental conditions. Currently however, there is little information on the diversity and distribution of *Symbiodinium* clades hosted by coral populations in Philippine archipelagic waters. In this study, we utilized various molecular approaches to characterize *Symbiodinium* diversity across coral species collected from a) natural populations which exhibit varied susceptibilities to environmental stress; b) coral fragments subjected to elevated temperature and lowered pH in a controlled hatchery environment, and fragments exposed directly to anthropogenic nutrient stress. Initial results show the utility of clade-specific PCR amplification in elucidating dominant *Symbiodinium* clades in coral fragments and PCR-DGGE fingerprinting of the zooxanthellae ITS2 gene region in identifying *Symbiodinium* to the subclade level. We present information on the diversity and distribution of zooxanthellae from candidate resilient coral species, which will be useful to characterize the potential influence of *Symbiodinium* on tolerance and resilience of the coral holobiont to environmental stress.

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## HISTORICAL AND SPATIAL DIMENSIONS OF HUMAN PROCESSES AND THEIR EFFECTS ON MARINE ECOSYSTEM SERVICES (Abstract ID: 30109)

Overfishing and terrestrial runoff are among the most important anthropogenic threats to marine ecosystem services. These threats are apparent in Puerto Rico, where research has shown persistent fish stock declines and coral reef degradation. Despite decades of management strategies, including controversial fishing regulations and the implementation of marine reserves, coral reef ecosystems continue to decline due to local threats and global climate change. Our work aimed to quantify environmental transformations observed in watershed, coastal and marine areas, and subsequently understand the relative importance of human dimensions over reported fish stocks in a spatial and historical context. We focused on Puerto Real, a traditional fishing community in southwest Puerto Rico, by generating and analyzing detailed decadal land cover maps (1963-2010), conducting reef characterizations, deriving water quality parameters from Landsat imagery and watershed modeling using Open-NSPECT, and by compiling local fish stock reports. We found striking historical changes in land cover, including a significant reduction in agricultural lands (54.8-0.5%) that gave way to increases in pasture lands (27.1-49.3%), forest cover (14.4-26.6%), and urban areas (4.4-22.7%). Analyses demonstrate that the positive effects of reforestation on water quality are outweighed by urban settlements along the coastal watersheds. Furthermore, temporal degradation and linear gradation between nearshore and off-shore coral reefs condition appears related to their proximity to sources of in-land pollution. These findings are strong evidence of the need for rigorous controls over land use practices.

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## DIFFERENCE OF CALCIFICATION RATE IN THE CORAL *PORITES LOBATA* FROM THE EASTERN TROPICAL PACIFIC: THE EFFECT OF THE MORPHOTYPE AND THE GENDER (Abstract ID: 27910)

Morpho-plasticity in colony structure is an adaptive strategy upon which some coral species rely to take advantage of changes in their environment. Despite the importance of morphologic variability, growth and calcification rates of different coral morphotypes, as well as gender effects on coral morphology, have not been undertaken in the Eastern tropical Pacific. Comparisons of annual extension rate (cm $yr^{-1}$), skeletal density (g $cm^{-3}$), and calcification rate (g $cm^{-2}$ $yr^{-1}$) was evaluated in columnar, massive, and free-living morphotypes of the common reef-building coral *Porites lobata* distributed in the Central Mexican Pacific. The results showed significant differences in extension rate, skeletal density, and calcification rate among morphotypes, and also differences in the interaction of the morphology and the gender. Massive form presented 33% faster rates in growth parameters compared with columnar and free-living corallith forms. Male colonies showed 40% faster calcification rate, than females for both columnar and corallith forms. These data reveal the extensive plasticity of this species and highlight the fact that each morphotype x gender group results in a different physiological response to environmental conditions. Therefore, *P. lobata* appears to be able to readily modify their growth form and efforts, developing different forms and growing at different rates, which helps to the species to maintain their distribution over the coral reef and contribute as a framework building species in the region.

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## ENVIRONMENTAL CONTROLS ON THE DEVELOPMENT AND DEMISE OF FLORIDA'S CORAL REEFS (Abstract ID: 28061)

The extraordinary scale and magnitude of recent coral-reef degradation highlights the urgent need to better understand the long-term controls on reef decline and resilience. One way to gain insight into the future of coral-reef ecosystems is to evaluate their response to environmental disturbances in the past. Although the decline in Florida's coral populations is a recent phenomenon, we show that reef accretion has been negligible on the Florida Keys reef tract (FKRT) for several millennia. Using more than 60 reef cores from throughout the FKRT, we reconstructed region-wide trends in reef development over the last 10,000 years. We used these records to evaluate the relative contributions of regional changes in sea level, climate, and oceanography to the historic shutdown of reef building. Our results support previous research (i.e., the inimical waters hypothesis), which suggested that changes in regional oceanography associated with rising sea level contributed to the collapse of reefs in the middle Keys by the mid-Holocene; however, our records imply that these changes occurred at least 1000 years earlier than previously thought. Furthermore, the region-wide decline in reef accretion by the late Holocene indicates that the demise of Florida's reefs may have ultimately been driven by larger-scale changes in climate and/or sea level. We conclude that although the increasing frequency of environmental disturbances will likely continue to threaten reef development, local oceanography may have the potential to modulate the response of reefs to larger-scale perturbations.

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MARINE MONITOR: A LOW COST RADAR FOR MARINE PROTECTED AREAS (Abstract ID: 28884)

Effective surveillance is essential for marine protected area (MPA) enforcement. Currently, local managers often lack affordable technology, especially in remote locations in the developing world. To address this gap, the Anthropocene Institute (AI) has developed the Marine Monitor (M2) system to lower the cost of MPA enforcement. M2 uses off-the-shelf radars to automatically detect up to 30 vessels up to 10nm offshore. Managers can define MPA boundaries and trigger alarms based on vessel speed and time spent within zones. E-mail alerts can also be configured and sent based on vessel activity. AI's software enables real-time viewing and playback of stored vessel activity, through a public, online map interface. Using live and historical vessel data, managers can focus their efforts on specific protected areas, view human use patterns within MPAs, and strategically enforce regulations. M2 incorporates a low power off-the-shelf radar, satellite telemetry, a dedicated PV power source, and shippable marine grade radar mast. The M2 system has been successfully tested in California at a fraction of the cost of current MPA surveillance systems. We are completing the first field installation in Micronesia in partnership with OneReef Worldwide Stewardship, and will continue improving software and overall system functionality. Local communities are requesting this resource in Micronesia, Palau, Indonesia, and beyond. By providing affordable radar enforcement, M2 will play a critical role in the successful implementation of nearshore MPAs and enhance conservation efforts globally.
http://anthropoceneinstitute.com/MarineMonitor

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THE RELATIONSHIP BETWEEN HETEROTROPHY AND INORGANIC NUTRIENT AVAILABILITY IN THE SCLERACTINIAN CORAL T. RENIFORMIS UNDER SHORT-TERM TEMPERATURE INCREASE (Abstract ID: 27789)

Coral bleaching caused by global increases in surface seawater temperature is one of the greatest threats facing coral reefs. Eutrophication, i.e. increased inorganic nutrients, caused by coastal runoff can exacerbate the effects of bleaching on corals. However, coral feeding on zooplankton (heterotrophy) can alleviate the effects of bleaching on some corals and confer resilience. Paradoxically, in nature it is rare to find high zooplankton densities without high inorganic nutrients. This study aimed to disentangle the effects of heterotrophy and inorganic nutrients on the physiological response of *Turbinaria reniformis* subject to short-term thermal stress. Three different inorganic nutrient ratios were tested: control (ambient SW, 0.5 µM NO3, and 0.1 µM PO4), NO3 only (ambient SW and 2 µM NO3), and NO3+PO4 (ambient SW, 2 µM NO3, and 0.5 µM PO4). Each nutrient level was replicated four times such that two tanks were exposed to heterotrophic food sources, and two were not. The results show a detrimental effect of NO3 alone on coral photosynthetic processes and calcification rates under thermal stress when associated with heterotrophy. However, NO3+PO4 enrichment maintained coral metabolism and calcification under thermal stress and enhanced physiological parameters when in concert with heterotrophy. These results shed light on the complex relationship between inorganic nutrients and heterotrophy, and highlight the relevance of N:P stoichiometry as a determining factor for the health of the holobiont that may be adapted to specific nutrient ratios in the surrounding environment.

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AN ACCURATE AND COST-EFFECTIVE REEF SURVEY METHOD: VIDEO TRANSECTS WITH GOPRO® TECHNOLOGY (Abstract ID: 29727 | Poster ID: 549)

As climate change continues to threaten coral reef ecosystems, the importance of efficient and accurate means of assessing coral reef health continues to grow. Traditionally, scientists have utilized manual survey methods to quantify species richness, abundance, and diversity on coral reefs. These manual survey methods require technical coral identification skills in the field and can be time intensive for sites with high coral cover and diversity. Here, we quantified coral abundance and diversity of 13 reef sites along the Mesoamerican Barrier Reef System (MBRS) using two methods: 1) a modified Atlantic and Gulf Rapid Reef Assessment (AGRRA) manual survey methodology and 2) video assessments using GoPro® video technology, a less expensive alternative to more popular stereo-video techniques. At each site, 60m$^2$ of reef was surveyed via the AGRRA methodology and 120m$^2$ was surveyed via the video methodology. Both methods identified the same trends in coral species richness, abundance, and diversity at each site; however, the video method also allowed for a more accurate calculation of percent coral cover. The congruent results of the two methods used here indicates that the use of GoPro® video technology can allow for faster surveys that are as accurate as manual survey methods while remaining more cost effective than stereo-video methods. The use of GoPro® video technology in reef surveys will allow for greater efficiency and reliability of monitoring in the field, an important advancement for scientists, reef managers, and conservationists worldwide.

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IS PHOTOSYNTHESIS REQUIRED FOR SYMBIOSIS ESTABLISHMENT AND/OR MAINTENANCE IN CNIDARIANS? (Abstract ID: 28465)

The mechanisms by which cnidarians recognize and take up their Symbiodinium endosymbionts remain largely unknown and may involve the physical, chemical, and/or metabolic properties of the algae. When some Symbiodinium strains are grown in glucose-containing medium, they undergo a loss of peridinin and chlorophyll pigments, a reduction in photosynthetic activity, and alterations to the cell surface. In this study, we used the sea-anemone model system Aiptasia to ask if these changes in the algae affect their uptake by a host. In comparison to algae grown without glucose, the glucose-grown algae were taken up significantly more slowly, if at all, by both aposymbiotic adults and larvae, even when no glucose was present in the seawater during infection. Moreover, addition of 28 mM glucose to the seawater during infection inhibited uptake of algae by both adults and larvae even when the algae had been grown without glucose. To ask if these effects of glucose reflected the reduction in algal photosynthesis, we attempted to infect adult, aposymbiotic animals with algae that had been cultured in the light without glucose, but performing the infections either in the dark or in the presence of 25 µM DCMU, a specific inhibitor of photosystem II activity. In both cases, little or no algal uptake was observed. Taken together, these results suggest that although other factors (such as recognition of algal surface markers by host receptors) may also be involved, algal photosynthesis plays a key role in initiation, establishment, or maintenance of cnidarian-Symbiodinium symbiosis.

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FINE –SCALE SAMPLING OF A. HYACINTHUS DURING AN ACUTE HEAT SHOCK, ILLUMINATES POTENTIAL IMMUNE GENE REACTIONS AND INTERACTIONS (Abstract ID: 27982)

Little is understood about when immunity and stress genes are activated during heat stress in coral reefs. Previous studies examining heat stress in corals collected samples after at least a day of heat stress. Nothing is known about when genes become active during heat stress, and what their temporal patterns of expression look like. In order to address this, we have sampled six individual corals every half an hour, over a 5-hour acute heat shock to understand the fine scale pattern of gene expression. From this dataset we have found that there are varying patterns of expression between individual immunity genes, and co-expression modules predictive of stress or bleaching found in previous studies, have fluctuating expression profiles. This dataset is the first to examine fine scale timing of heat stress, and will inform us about reaction times of genes and immunity gene interactions.

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HETEROTROPHY PROMOTES PHOTOSYNTHATE TRANSLOCATION IN A SYMBIOTIC CORAL DURING THERMAL STRESS (Abstract ID: 28250)

Large-scale coral bleaching events, as a result of elevated seawater temperatures, have been identified as one of the major causes for worldwide coral mortality. The energetic status of corals is emerging as a particularly important factor that determines the corals' vulnerability to thermal stress. However, detailed studies that trace the flow of carbon (energy) from symbionts to coral host are still missing, although such studies are essential to assess the nutrient status of corals and predict their resilience to the stress. The pres-

ent study reveals the impact of thermal stress on the nutritional interactions between symbionts and host in the scleractinian coral *Stylophora pistillata*. First, we demonstrated that the amount of photosynthetically assimilated carbon retained in the symbionts was significantly higher during thermal stress than under non-stressful conditions. This higher photosynthate retention in symbionts lowered the rates of energy transfer to the host, which required the use of tissue energy reserves to sustain its respiratory needs. In addition, we found a strong positive correlation between carbon translocation and coral calcification, thus a significant decrease in skeleton growth was observed during thermal stress. This study also provides evidence that heterotrophy modulates the negative effects of thermal stress on coral physiology, and enhances the re-establishment of normal nutritional exchanges between symbionts and host.

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THE EMERGENT GEOGRAPHY AND GEOPOLITICAL (MIS)ALIGNMENT OF DISPERSAL CORRIDORS AND BARRIERS ACROSS THE INDO-WEST PACIFIC (Abstract ID: 30029)

Although barriers to dispersal are known to contribute to the distinctiveness of communities, species and populations, the importance of the biophysical processes associated with permeable barriers is not well understood. In this study, we predict the geographic location and strength of multitaxon dispersal barriers across the Indo- West Pacific Ocean. Specifically, we ask three questions: (1) What biological attributes are important in influencing the location and strength of dispersal barriers? (2) What is the geographic configuration of multitaxon dispersal barriers? (3) Is there geographic concordance with previously described and empirically based barriers? Although individual taxa varied in their predicted fine-scale population connectivity, there was broad-scale consistency in the location of dispersal barriers. Across all trait combinations, reproductive output (fecundity and density of reproductive adults), reproductive strategy (spawning phenology) and the length of the larval dispersal phase determined the strength of barriers across the seascape. Finally, I describe a new approach for quantifying the ecological-institutional alignment and mismatch across this environmentally and politically complex seascape. Intersecting these dispersal barriers and corridors with estimates of cross-country institutional linkages related to marine management, we identify geopolitical fit and misfit between the region's ecological processes and its governance.
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CELLULAR LOCALIZATION AND POTENTIAL PHYSIOLOGICAL ROLES OF VACUOLAR PROTON ATPASE, SODIUM POTASSIUM ATPASE, SLC4S, AND PLASMA MEMBRANE CALCIUM ATPASE IN CORALS (Abstract ID: 29734)

The movement of molecules across cell membranes and epithelia is facilitated and energized by ion-transporting proteins such as ATPases and ion exchangers, co-transporters and channels. We studied the cellular localization and physiological roles of some ion-transporting proteins potentially involved in calcification, photosynthesis and pH regulation in the corals Acropora yongei and Stylophora pistillata. The vacuolar proton ATPase (VHA) was abundantly present in symbiosome membranes and participates in a carbon concentrating mechanism for Symbiodinium photosynthesis. Additionally, VHA was present in the coelenteron-facing membrane of aboral gastrodermal cells, suggesting it removes H+ away from the site of calcification. The Na+/K+-ATPase (NKA) was abundantly present in the basolateral membrane of calicoblastic cells, indicating a role in calcification. However, only A. yongei expressed NKA in the apical membrane of oral ectodermal cells, suggesting a species-specific mechanism for taking up molecules from seawater. Slc4 HCO3--transporters displayed a similar species-specific localization pattern. Finally, a plasma membrane Ca2+ ATPase (PMCA) was found throughout coral tissues. Surprisingly, PMCA was not located in the plasma membrane of calicoblastic cells, thus questioning the previously assumed role of PMCA in transporting Ca2+ into the subcalicoblastic fluid. Knowledge on protein cellular localization and function can greatly contribute to our understanding of coral cell biology, which in turn is essential for studying and predicting coral responses to stress.
https://scripps.ucsd.edu/labs/mtresguerres/

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TERRESTRIAL SEDIMENT EFFECTS ON HAWAIIAN CORAL REEFS: PAST, PRESENT, AND FUTURE (Abstract ID: 28950)

Long-term estimates of erosion rates on Hawaiian watersheds range from 0.01 to 0.1 mm/yr. In contrast, recent measurements shows erosion rates up to 10 mm/yr. One explanation for this increase is the arrival of humans and the accompanying large-scale changes across the landscape due to land development, feral and domestic ungulates, and agriculture. Sediment effects on reef ecology depend on grain size and composition, depositional area, total load, wave energy, water circulation, and the coral community composition. There is uncertainty about how climate change will alter terrestrial sediment impacts to Hawaiian reefs. We lack forecasts of rain intensity (which drives terrestrial erosion). Existing models indicate that by the year 2100, average rainfall across watersheds near coral reefs will stay the same or decrease. It seems unlikely that the overall changes in precipitation will lead to a substantial increase in terrestrial runoff compared to current levels. Management of terrestrial sediment on Hawaiian reefs may be best ameliorated by management of sediment sources in watersheds regardless of climate change. Watersheds that discharge into protected bays and areas of restricted circulation are more likely to affect reefs in those environments than reefs in high-energy marine settings. Finally, additional research on the ability of Hawaiian corals to adapt to sediment loading, in conjunction with other climate-change impacts, may provide insights on how reefs in Hawaii will develop in the future.

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AN ASSESSMENT OF SOCIO-ECONOMIC AND INSTITUTIONAL LINKAGES IN TRANSBOUNDARY MARINE PROTECTED AREA NETWORKS IN THE PHILIPPINES (Abstract ID: 29932)

The decentralized government system of the Philippines impedes establishment of functional marine protected area (MPA) networks, because local governments are limited by their jurisdictions. To address this challenge, transboundary governance arrangements were recommended to scale up to form networks. The Philippine Marine Key Biodiversity Area Project, a technical assistance and development initiative, aims to improve conservation success of existing and new MPAs and networks by addressing gaps in protection of ecological processes. However, since transboundary governance is key to implementing networks, we suggest consideration of institutional and socioeconomic parameters in optimal network designs. We conducted case studies of five MPA networks with different governance arrangements to determine key socioeconomic and institutional design parameters. We found that various configurations of the networks, emerged based on the strength or weakness of the following parameters: (i) consistency of policies between relevant local governments; (ii) financial benefits are exported beyond the MPA governance boundary; (iii) existence of medium to long term plans with funding commitment developed by regional or national planning agencies; (iv) support from communities, and bridging organizations; and (v) adherence to unified policies or other transboundary agreements Our findings reiterate the need to consider social, economic and political complexities for designing MPA networks in order to reduce transaction and management costs, and improve their sustainability.
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ASSESSMENT OF THE CURRENT STATUS OF CORALS AND ASSOCIATED FAUNA OF SINDHUDURG COAST IN MAHARASHTRA, INDIA (Abstract ID: 29505)

Information on corals and associated fauna of Sindhudurg coast in India is not adequately known. Intertidal, subtidal and underwater surveys were conducted to ascertain the presence of corals and associated fauna along the Sindhudurg coast of Maharashtra in India for two years from November 2013 to November 2015. Permanent Monitoring Plots were established for health assessment of corals. Effect of anthropogenic activities and factor influencing the distribution and abundance of corals and associates along the Sindhudurg coast was also enumerated. Coral coverage was assessed through employing photo-quadrats and LIT. Representative samples of species were collected from the site for proper identification and for deposition at the NZC of ZSI. The survey conducted revealed >20 species of corals along Sindhudurg coast along with seven new records among which Polycyathus verrilli Duncan, 1889, Goniopora minor, Pavona bipartita Nemenzo, 1980 and Leptastrea purpurea (Dana, 1846) are unique records. The sub-tidal/underwater surveys conducted also revealed several species of interesting coral associated Fishes, Seahorse, Sponges, Gorgonians, Seafans, bivalves, Chiton, Opisthobranch, Brittle stars, Polychaete and Blue Button Jellyfish. There are anthropogenic pressures viz. tourism, fishing etc. mounting on the ecosystem. This paper deals with assessment of corals and associated fauna of Sindhudurg coast, one of the important coral reef ecosystems in the mainland west coasts of India along with conservation measures.

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PRELIMINARY REA OF MYEIK (MERGUI) ARCHIPELAGO, MYANMAR (Abstract ID: 29408)

Myanmar has a reported total coral reef area of 187,000ha, although they remain largely unexplored and to a large extent, reefs in Myanmar have been assumed to be in similar condition to hundreds of years ago, due to political and geographic isolation. However, over the past few years, reports from tour operators suggested that the marine resources of the Myeik Archipelago had been severely degraded. Between February 2014 and March 2015, four survey voyages were undertaken and more than 100 sites were surveyed by researchers under the auspices of IUCN and FFI along the 600km length of the Archipelago. Here, we present a precis of data from those surveys. More than 280 species of hard coral, and 400 species of teleost fishes were observed, along with 73 species of echinoderms, more than 100 species of mollusc and 45 species of sponges. The surveys found that – for the most part – the abundance of key reef infrastructure species is generally low, and the overall condition of most coral reefs is either poor or very poor. Reefs closer inshore varied widely in condition; where they were accessible or easy to fish, the reefs were often badly degraded. Where conditions made fishing difficult, or where the fishermen were generally unaware of the reef habitat (usually, it would seem, because of high turbidity and strong currents), reefs were often outstandingly diverse and generally healthy. Biogeographic affiliations within the Myeik Archipelago and eastern Indian Ocean are as yet unclear, although diversity and level of endemism appear higher than in Thailand to the south.

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DRIVERS OF RELATIVE SPECIES ABUNDANCES REGULATE THE DIVERSITY-STABILITY RELATIONSHIP OF CORAL REEF FISHES (Abstract ID: 28527 | Poster ID: 215)

Fish communities are important for maintaining the stability of coral reef ecosystems. High species richness in a fish community stabilizes total abundance fluctuations (i.e., higher species richness increases community stability), ensuring continued ecosystem function despite environmental perturbations. Additionally, even when species richness is constant, factors that drive relative species abundances can influence community stability. However, little is known about how species richness and drivers of relative species abundances interact to regulate community stability in nature, particularly at spatial scales comparable to the scale of marine reserves. Here, we used a fish community time series dataset across a large spatial extent of the Great Barrier Reef to show that (1) community stability increases with species richness, and (2) community stability increases with the strength of niche-driven, more than stochastic-driven, variations in relative species abundances. Moreover, species richness and drivers of relative species abundances appear to influence stability through inter-specific asynchronous dynamics and intra-specific population fluctuations, respectively. The two effects are not correlated, indicating that richness-related and relative abundance-related drivers of community stability did not covary over the coral reef seascape. Our findings elucidate multiple pathways of stability in reef fish communities. Spatial planning of large-scale marine reserves should consider not only species diversity but also niche-forming mechanisms if the goal is to sustain ecosystem stability.

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HIGH TOLERANCE OF CORALS FROM MARGINAL ENVIRONMENT IN HONG KONG TO HYPOSALINITY AND PREFERENCE OF CORALLIVORY ON OSMOTIC-STRESSED CORALS (Abstract ID: 29475 | Poster ID: 304)

Interactive effects of environmental variables could affect the health of coral colonies which are reported to be sensitive to fluctuation in seawater salinity. We hypothesize that the osmotic-stressed corals may subsequently become more prone to other disturbances like corallivory. This hypothesis was tested with a series of laboratory-based experiments set up to determine the osmotic tolerances of four coral species (*Acropora valida, Pavona decussata, Platygyra acuta* and *Porites lobata*) found in the marginal community in Hong Kong. These corals were first treated separately at 9, 12, 15, 18, 24 and 34 psu for 3 days, before being exposed to corallivorous snails*Drupella* for a prey preference assay. The results indicated Hong Kong corals were generally tolerant to hypo-salinity stress as low as 18 psu and with *P. lobata* being the most tolerant. It survived under 9 psu with only around 5% of tissue loss. *Drupella* snails preferentially attacked corals exposed to lower salinities. Additional *Drupella* prey-choice assays were conducted to assess the relative vulnerability of these four coral species exposed at 18 psu (stressed) and 34 (normal) conditions. A shift in prey preference was observed with *A. valida* exposed to 18 psu being the most preferred prey. These findings supported our hypothesis and demonstrated that changes in salinity could alter the prey-preference of corallivores. This could subsequently affect the composition of a coral community by removing the more vulnerable species. This project is supported by RGC-GRF 14122215.

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OCTOCORAL COMMUNITY ECOLOGY AT TWO SITES OF CONTRASTING ENVIRONMENTAL CONDITIONS IN ST JOHN, US VIRGIN ISLANDS (Abstract ID: 28888)

To better understand how octocoral communities on Caribbean coral reefs respond to environmental conditions, we quantified their synecology on two reefs (9 m depth) with contrasting physical conditions. One reef at Cabritte is exposed to easterly winds and waves, while the other, in Europa Bay (1.4 km west) is partially sheltered and characterized by higher sedimentation. Octocoral population density was 2-fold higher at Cabritte than Europa Bay, and the most abundant species (Antillogorgia americana, Gorgonia ventalina, Eunicea flexuosa) were taller at Cabritte. Densities of octocoral recruits were lower at Europa than Cabritte in winter, but similar at both sites in summer. Species richness was similar between sites, with 34 species at Europa Bay, 35 at Cabritte, and 30 common to both sites. Multivariate analysis of species-specific abundance of adults and recruits revealed that the two sites differed in octocoral community structure. The large number of common species at the two sites suggests that these species have broad ecological niches defined by a wide spectrum of environmental conditions. However, their differences in colony sizes and relative abundances suggest that their populations respond differently to the variation in environmental factors. In comparison to seminal octocoral studies conducted in the Caribbean in the 1970's, the species composition and community structure of octocorals in St. John is similar, suggesting that recent reports of increasing abundance of octocorals in the Caribbean reflect community range extensions and not novel communities.

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IMPROVING CONSERVATION OUTCOMES FOR DATA-POOR CORAL REEFS AFFECTED BY FUTURE OIL PALM DEVELOPMENT IN PAPUA NEW GUINEA (Abstract ID: 28473)

Clearing forests for oil palm plantations is a major threat to tropical biodiversity, and may potentially have large impacts on downstream marine ecosystems (e.g., coral reefs). We coupled terrestrial and marine biophysical models to simulate changes in sediment/nutrient composition on reefs, and predict the response of coral and seagrass ecosystems to different oil palm development scenarios. The condition of almost 60% of coastal ecosystems were predicted to heavily degraded (more than a 50% decline from their initial state) after 5 years if all suitable land was converted to oil palm. We evaluated the benefits of using global sustainability criteria for oil palm plantations, and found only slight improvements in ecosystem condition compared to the scenario where all forest was converted to oil palm. More stringent restrictions are required to substantially lower the risk of degradation; in particular limiting new plantings to hill slopes below 15 degrees. Evaluation of current plans for oil palm expansion identified ecosystems in marine conservation priority areas that will likely be heavily degraded in the future. We show marine conservation plans should be modified to prioritize turbid areas where coral communities may be more tolerant of increased suspended sediment in the water. The approach developed here provides guidelines for modifying marine conservation priorities in areas with oil palm development. Importantly, oil palm development guidelines cannot be truly ecologically sustainable unless modified to account for oil palm impacts on coastal marine ecosystems.

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HOW INVASIVE INDO-PACIFIC RED LIONFISH INTERACT WITH FISH PARASITES AND CLEANING MUTUALISMS NATIVE TO ATLANTIC CORAL REEFS (Abstract ID: 29030)

What makes invasive species successful, and how do they alter native populations and communities? We addressed these key questions within the context of the invasion of Atlantic coral reefs by Indo-Pacific red lionfish (Pterois volitans). To assess the role of parasites in this invasion, we compared infection rates of lionfish with sympatric carnivorous fishes at multiple locations in their invasive and native ranges. We found that invasive Atlantic lionfish had extremely few parasites when compared both to native Pacific lionfish and to native Atlantic fishes. Such "enemy release" may help to explain this successful invasion if lionfish consequently allocate more energy to growth and reproduction than to costly immune defenses. With few parasites to limit them, lionfish may consume ecologically important species, including cleaning gobies (Elacatinus spp.): ubiquitous, conspicuous fishes that clean parasites off other reef fishes. However, while lionfish will eat cleaning gobies during laboratory and field experiments, they quickly learn to avoid them, due to a previously undescribed skin toxin in these gobies. Additional field experiments revealed no change in the growth, survival, and behavior of newly recruited cohorts of the cleaner goby (E. genie) in the presence vs. absence of lionfish. Thus, cleaning gobies are among the few inhabitants of invaded reefs that escape the jaws of lionfish. Given their broad and voracious appetites, however, invasive lionfish will continue to affect native reef communities via predation on other ecologically important fishes.

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SUPER TYPHOON HAIYAN: INUNDATION, EROSION AND GROUNDWATER RECOVERY: KAYANGEL STATE, REPUBLIC OF PALAU (Abstract ID: 28262 | Poster ID: 393)

On November 06-07 2013, Super typhoon Haiyan passed directly over Kayangel Atoll in the northern area of Palau. The storm generated massive waves in the atoll's northeast through southeast quadrants and severely damaged reefs on the outer slope on the northern and eastern exposures. The waves eroded areas of the eastern shores of the islands, caused changes in the sand banks and flats within the lagoon, but left western to southwestern outer reefs and lagoon seagrass and patch reef communities largely untouched. Salt water intrusion from inundation and salt spray contaminated the fresh water lens of Kayangel Island. The impact of salt water intrusion and the recovery of the fresh water lens were examined in the year following the storm. The relations between lagoon and island ground water lenses were concluded using pressure loggers while salinity/depth of the island ground water lens was measured using hand-held water quality monitors. Aerial photographs before, immediately after and continuing to the present were used to examine inundation zones and recovery of vegetation on the islands. Ground truth surveys were used to validate interpretation of aerial images. At the nearby Ngeruangel/Velasco reef sunken atoll system the single island (Ngeruangel) was swept clean by the storm waves. The island grew slightly in size and elevation and migrated about 50 m distance from the storm. Marine communities on Velasco Reef were severely affected with massive shifting of sediments and erosion of the unusual Thalassodendron ciliatum beds found on the sunken atoll rim.

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ASSESSING THE PREVALENCE OF CYANIDE-CAUGHT FISH IN THE U.S. MARINE AQUARIUM TRADE (Abstract ID: 28852)

The United States is the world's largest consumer of coral reef fishes for aquariums with upwards of 11 million fish imported annually. The largest exporters of marine aquarium fish (MAF) are the Philippines and Indonesia, both of which are known for the widespread use of cyanide ($CN^-$) in MAF capture. $CN^-$ is metabolized into thiocyanate ($SCN^-$), and fish exposed to $CN^-$ excrete $SCN^-$ in their urine for at least 28 days post exposure. The detection of elevated levels of $SCN^-$ in seawater that held MAF indicates likely exposure to $CN^-$. In our study, the top ten MAF species imported by the U.S. were identified and purchased from a number of retailers and wholesalers across the U.S. We held individual MAF specimens in synthetic seawater for 24 hours and utilized High-Performance Liquid Chromatography with ultraviolet detector (HPLC-UV) to screen for $SCN^-$ in the holding water. $SCN^-$ was detected in a significant number of samples. No $SCN^-$ was detected in holding water that contained control specimens obtained from captive breeding facilities. This study shows that detection of $SCN^-$ in holding water is applicable in the U.S. supply chain and can be used to non-invasively and non-destructively screen MAF for exposure to cyanide during collection in source countries.

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PIGMENTED PSEUDOALTEROMONAS SPECIES CAN PROTECT CORAL MONTIPORA CAPITATA FROM INFECTION BY THE PATHOGEN VIBRIO CORALLIILYTICUS STRAIN OCN008 (Abstract ID: 29242 | Poster ID: 136)

Coral reefs are among the most diverse and productive ecosystems in the ocean and are threatened by a number of bacterial infections. *Vibrio coralliilyticus* OCN008 is a bacterium that induces acute *Montipora* White Syndrome (aMWS), a tissue-loss disease affecting *Montipora capitata*, a major reef-building coral in Kaneohe Bay, Hawaii. The bacteria that colonize the coral surface are hypothesized to protect against bacterial pathogens like OCN008. Two species of pigmented bacteria, *Pseudoalteromonas rubra* and*P. luteoviolacea*, were isolated from healthy *M. capitata* and displayed antibacterial activity against OCN008. When healthy fragments of *M. capitata* were pre-inoculated with the pigmented strains and then exposed to OCN008, the infection rate was reduced by 60% and 100%, respectively. Neither of the pigmented strains had any observable detrimental effects on*M. capitata*. It is hypothesized that inoculation with these pigmented bacteria act as probiotics and protect *M. capitata* from OCN008 infection through the production of antibacterial compounds. Therefore, a genetic screen was developed to determine what compound(s) are produced by these bacteria and if antibacterial activity is involved with protection of the coral. This is the first *in vivo* evidence to show how bacteria of the coral microflora can protect the host from infection.

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ENVIRONMENTAL REGULATION OF THE SYMBIODINIUM PROTEOME (Abstract ID: 29207)

The vast genetic diversity of Symbiodinium denotes a great adaptability to different environments. Genome sequencing has been used to unveil differences in the physiological machinery to explain different adaptations. However, environmental regulation of acclimation pathways including, photochemistry and photoprotection for Symbiodinium appear to be governed post-translationally and thus undetectable via transcriptomics. Proteomics therefore provides an extremely powerful platform to support the increasing use of transcriptomics to understand the physiological 'wiring' adapted among Symbiodinium to thrive across different environments. Therefore we contrasted the changes in the proteome among Symbiodinium species in culture (ITS2 types A1, A13 and C1) with known differences in stress tolerance and life history ("mutualists" versus "parasites"), and how their proteomes are further modified at different growth light (photonflux:100/350µmol•m2•s-1) and temperature (26/30°C) as well as at thermal stress (33°C). Using 2D-PAGE and LC/MS-MS proteomics we observed differential regulation between clades of chloroplast precursors, structural motifs, transcriptional regulators and heat shock proteins. These results in addition with characterization of growth rates and photo-physiological traits provide new insight into how emergent physiological trait expression is underpinned by complex re-organisation of the proteome; consequently, new understanding of the pathways at play that regulate Symbiodinium competitive fitness under both steady state and anomalously stressful conditions.

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THE ROLE OF PATHOGENS, PROBIOTICS, AND THE BACTERIAL MICROFLORA IN ACUTE *MONTIPORA* WHITE SYNDROME (Abstract ID: 28517)

Tissue loss diseases destroy coral and can lead to colony mortality, which exacerbates the deteriorating state of the world's reefs. To defend against pathogens, the bacteria colonizing the coral, termed the normal microflora, are thought to protect the coral host through competition for nutrients and space or the production of antibacterial compounds. The bacterial pathogen*V. coralliilyticus* strain OCN008 infects and causes tissue loss in the reef-building coral *Montipora capitata* and produces the antibiotic an-

drimid. Under laboratory conditions, 85% of *M. capitata* fragments exposed to OCN008 developed tissue loss, however, a mutant strain incapable of producing andrimid displayed a 60% reduction in infection rate. Treatment of *M. capitata* fragments with antibiotics that cleared the microflora allowed the mutant strain to infect at wild-type levels, implicating andrimid in mitigation of the protective effects of the coral microflora. Strains of*Pseudoalteromonas luteoviolacea* and *P. rubra* isolated from healthy *M. capitata* release compound(s) into culture medium that inhibit OCN008 growth. When *M. capitata* fragments were pre-inoculated with *P. luteoviolacea* or *P. rubra*, OCN008 infection was reduced by 60% and 100%, respectively. Antibiotic production by OCN008 or its proximal effect, alteration of the coral microflora, is required for optimal infection and demonstration of a probiotic effect from bacteria of the coral microflora provides *in vivo* evidence for competitive antibacterial production between pathogens and the normal microflora.

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GENETIC LARVAL IDENTIFICATION AND QUANTIFICATION AS NEW TOOLS TO INVESTIGATE EXTEND AND CAUSES OF CROWN-OF-THORNS OUTBREAKS (Abstract ID: 28604)

Predation by Crown-of-Thorns Seastars (CoTS) is a major contributor to the coral reef decline in the Indo-Pacific Region. Testing hypotheses about CoTS outbreaks is hampered by our inability to investigate distribution of larvae because they resemble other asteroid and some holothuroid larvae. We developed several genetic markers and tested these on plankton samples in outbreak areas of the northern Great Barrier Reef (GBR), and in Okinawa, Japan. The method was verified through microscopy and amplification of single wild and cultured larvae. Most samples collected during the spawning season on the GBR contained CoTS larvae, suggesting very high larval numbers in the plankton. Larvae were also identified in several samples in Okinawa. During the spawning season In Japan, several early larvae were identified near Miyako Island and dense population of later stages were found near Sekisei Lagoon. A newly developed rtPCR assay reliably quantified gene copy numbers over 7 orders of magnitude. We now started monitoring to quantify larvae to test several aspects of their ecology. These studies include a) resolving the exact spawning times by temporal studies over the spawning season, and b) spatial quantification (small scale vertical and large scale horizontal) in relation to water quality parameters to further test the 'nutrient hypothesis'. The latter work is complemented by studies on the role of food quantity and quality and the effect of other environmental variables on larval development and survivorship.

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SEASONAL VARIATION IN, AND PROJECTED EFFECTS OF CLIMATE CHANGE ON, CALCIFICATION RATES OF ACROPORA DOWNINGI IN THE NORTHEASTERN PERSIAN GULF (Abstract ID: 29188 | Poster ID: 316)

With on-going climate change, there is a strong interest in understanding how changes in environmental conditions will impact on coral growth and thereby, reef accretion. In this study, we explore seasonal variation in in-situ calcification rates of Acropora downingi in the northeastern Persian Gulf, where there are marked seasonal differences in temperature, irradiance, and aragonite saturation (Ωarag). Calcification rates of A. downingi varied greatly among seasons and had a significant, but non-linear, relationship with temperature ($r2 = 0.30$) and a significant linear relationship with irradiance ($r2 = 0.36$). There was not, however, any apparent effect of Ωarag on intra-annual variation in calcification ($r2 = 0.02$). Differences in calcification were largely attributable (~ 57.4%) to seasonal differences in irradiance, while temperature accounted 37% of intra-annual variation in calcification, largely constraining coral growth in warmer months. As such, we predict that ocean warming will lead to declines in calcification during spring, fall, and especially summer, though possibly enhancing calcification during the winter months. Overall, there is likely to be a net decline in annual calcification for A. downingi in the Persian Gulf. Comparisons of our findings to other recent studies show that proportional declines in annual calcification of A. downingi were very similar to that reported for other corals in subtropical locations. As such, we suggest that ongoing climate change (and specifically, ocean warming) will have generally negative effects on coral growth, even at subtropical locations.

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PROTECTING CORALS UNDER THE ENDANGERED SPECIES ACT CAN PROMOTE CORAL REEF RECOVERY (Abstract ID: 28940)

Reef-building corals are dying at accelerated pace due to climate change and other anthropogenic threats, resulting in negative effects for ecosystem function and services. Although the science on the causes and consequences of coral loss is comprehensive, conservation actions have been largely insufficient to actively reverse coral decline. The U.S. Endangered Species Act (ESA), one of the world's strongest biodiversity protection laws, has prevented the extinction of 99 percent of species under its care and has effectively promoted recovery. Currently, 22 coral species are listed as threatened under the ESA with seven species in the Atlantic Ocean and 15 in the Pacific Ocean. We discuss how the ESA works, the tools it provides to conserve threatened corals and how protection can ultimately promote coral reef recovery. ESA protection requires the development of recovery plans that provide coordination, evaluation, and funding for coral conservation and new research. It leads to the protection of critical habitat areas in U.S. waters. It requires federal agencies to consult with biologists to minimize harms to corals and their critical habitat from government-approved activities including dredging, commercial fishing, construction, and projects emitting significant greenhouse gas emissions that contribute to warming. ESA protection also promotes greater awareness about threats to corals and public engagement in coral conservation. These protections can result in ecosystem-wide benefits by improving water quality, reducing pollution, and restoring degraded ecosystems.

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SIZE FREQUENCY DISTRIBUTION OF PORITES CYLINDRICA IN AN OFF-SHORE PHILIPPINE REEF (Abstract ID: 29869 | Poster ID: 657)

Life-history processes provide crucial information on reef responses to prevailing environmental conditions that are crucial in reef health studies and their implications to marine resource management. This study was conducted to provide species-specific information on the population dynamics of Porites cylindrica, a common coral species in an off-shore marine sanctuary in the Zamboanga peninsula, Philippines. It aims to track changes in size frequency distribution (SFD), mortality and growth patterns of P. cylindrica colonies inside the marine sanctuary over two time periods (2014 and 2015). Fifty one 1m x 1m quadrats in three (3) sites (n= 153) at 10-12m depth located around the island were photographed annually. Site 1 being the most exposed to land based sedimentation and 3 being the farthest. The cover, density and size structure of P. cylindrica were analyzed and compared for the two time periods. Also, Forty five (45) haphazardly chosen colonies were in situ photographed, tagged and measured for growth rate during 2014 and in 2015. P. cylindrica colonies were larger and denser in sites 2 and 3 compared to site 1. These results may serve as a benchmark indicator for coral reef health during marine sanctuary monitoring for upcoming disturbances and may give insights to the resiliency of P. cylindrica to sedimentation stress.

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STABILITY AND FUNCTIONALITY OF THE MICROBIAL COMMUNITIES ASSOCIATED WITH TEMPERATE GORGONIANS AND THE PRECIOUS RED CORAL *CORALLIUM RUBRUM* (Abstract ID: 29288)

Gorgonians are key habitat-forming species of temperate benthic communities. However, local human impacts and mass mortality events caused by elevated seawater temperatures related to climate change and microbial disease outbreaks are responsible for significant declines in gorgonian populations. Despite these threats, relatively little is known about the symbioses between gorgonian hosts and their microbial associates. While *Endozoicomonas* from the order Oceanospirillales are commonly associated with most anthozoans (up to 95%), we report that the microbiome of *Corallium rubrum* is dominated by Spirochaetes (70%) and to a lesser extent Oceanospirillales of the ME2 family (25%). This core microbiome, consisting of 12 bacterial species, was found to be highly stable on both spatial and temporal scales, suggesting that these bacteria are important symbionts of the red coral. In contrast, the *Endozoicomonas*-dominated microbiomes of other temperate gorgonians were found to undergo significant changes depending on local conditions. To elucidate the function of these divergent gorgonian-associated microbial communities and the effects elevated seawater temperatures, ocean acidification and eutrophication may have on their functionality, we conducted

meta-transcriptomic analyses on gorgonians and the red coral impacted by these stressors in experimental settings. We will present results from these studies showing a novel microbial symbiotic association within Anthozoans and how stress may impact the health of the coral holobiont through the disruptions of host-microbial symbioses.

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THE FIGHT AGAINST FINNING: WHO IS WINNING THE WAR? (Abstract ID: 27857)

Despite the current protection efforts as well as the introduction of more stringent laws regulating the hunting and trading of sharks (especially their fins), shark conservation is still recognized a major environmental challenge. The rapid growth in the demand for raw dried shark fins has led to a global exploitation of many elasmobranch species. Recent studies have also confirmed that the United Arab Emirates (UAE) is being used as an export hub and is currently the fourth largest exporter of shark fins to Hong Kong, with a large proportion of fins traded considered to be from species at high risk of global extinction (based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species)). Current management frameworks still reveal significant deficiencies with regard to legal protection of elasmobranchs, specifically associated with fishing methods and monitoring of finning practices. These problems however are not unique to the UAE but reiterate the facts that there are far-reaching issues pertaining the global management and protection of shark species. Even in a realm of improving conservation efforts, the current data on the success of shark finning prohibition might be mendacious when viewed in the light of looming species extinction. This paper therefore considers the regional regulatory framework that seeks to enhance shark protection and conservation.

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INCREASED TEMPERATURE IS THE DOMINANT DRIVER OF CLIMATE CHANGE IMPACTS ON *ACROPORA FORMOSA* (Abstract ID: 29173)

Increased seawater temperatures and ocean acidification due to rising $CO_2$emissions have serious impacts on coral reef ecosystems, although a full understanding remains elusive due to the large number of non-manipulative, correlative studies. Our experiment investigated the physiological and metabolic performance of the symbiotic coral *Acropora formosa* under temperature and $pCO_2$ conditions (both as individual factors and as combined treatments) expected by the end of this century under business-as-usual emissions. After eleven weeks of exposure to increased $pCO_2$ concentrations alone, no significant changes were observed in productivity, net growth and calcification rates (measured using the alkalinity anomaly technique), and survival rates compared to the control treatment. However, when exposed to increased temperatures whether or not in combination with increased $pCO_2$, *Acropora formosa* responded with a sharp decline in productivity. Over time, these changes produced a net negative energetic budget, followed by a cessation of growth, negative calcification rates (i.e. decalcification) and extensive mortality. Our results indicate that temperature is the dominant factor in reducing growth and metabolism of *Acropora formosa* under future climatic conditions.

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DOWNSCALED PROJECTIONS OF CORAL BLEACHING CONDITIONS THAT CAN INFORM CONSERVATION PLANNING (Abstract ID: 29484)

Increasingly frequent severe coral bleaching is among the greatest threats to coral reefs posed by climate change. Global climate models (GCMs) project great spatial variation in the timing of annual severe bleaching (ASB) conditions; a point at which reefs are certain to change and recovery will be limited. However, previous model-resolution projections (~1x1°) are too coarse to inform conservation planning. To meet the need for higher-resolution projections, we generated statistically downscaled projections (4-km resolution) for all coral reefs; these projections reveal high local-scale variation in ASB. Timing of ASB varies >10 years in 71 of the 87 countries and territories with >500km2 of reef area, indicating the projections warrant consideration in most reef areas during conservation and management planning. The global average projected timing for ASB onset is 2043. Locations projected to experience ASB after 2052 and before 2034 are relative climate winners and losers, respectively. There are relative climate winners and losers in 16 of the top 20 countries in terms of reef area. Among these, Cuba (11.3%) and Australia (8%) have the highest percentages of relative climate winners. Coral reef futures clearly vary greatly among and within countries. Emissions scenario RCP4.5 represents lower emissions mid-century than will eventuate if pledges made following the 2015 Paris Climate Change Conference (COP21) become reality. RCP4.5 adds ~15 years on average before ASB occurs when compared to RCP8.5; however, >75% of reefs still experience ASB before 2070 under RCP4.5.

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REEFGUARD: AN INDUSTRY LED APPROACH TO ASSISTED REEF REHABILITATION WITH 'LAB'-CULTURED JUVENILE CORALS OBTAINED FROM NATURAL CORAL SPAWNING EVENTS (Abstract ID: 28713)

In 2010, Dutch dredging and marine contractor Van Oord launched a Coral Rehabilitation Initiative (2010 – 2015). Its aim is to enhance the assisted rehabilitation of degraded natural coral reefs by out-planting (tens to ultimately hundreds of thousands) 'lab'-cultured juvenile corals obtained from natural coral spawning events. A key challenge is to demonstrate that already proven small-scale coral breeding techniques can be scaled-up and applied in the field to promote environmental gain around marine infrastructure projects. An innovative mobile laboratory, named ReefGuard, was developed to ensure the availability of a controlled environment to facilitate fertilisation, primary settling and initial outgrowing of the larvae before outplacement. After its construction in 2013, ReefGuard was applied in three field trials. The first two trials were executed near Ningaloo Reef in Coral Bay Australia (2014 and 2015). The third trial was executed in Coral Harbour on New Providence, Bahamas (2015). The trials involved three species of acropora corals, in-situ as well as ex-situ gamete collection, and employed 10.000, 36.000 and 20.000 settlement tiles respectively. Tiles with settled larvae were placed in the field as part of a scientific survival experiment. The results that are going to be presented include the design of the ReefGuard, its use in up-scaling consecutive breeding steps, the settlement and mortality rates encountered and a number of practical aspects that are crucial in bringing this technology towards operating standards that are acceptable to industry.

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THE DIVERSITY AND ROLES OF CORAL-ASSOCIATED VIRUSES (Abstract ID: 27822)

The cellular microorganisms associated with corals are known to confer benefits to their host by various mechanisms, including photosynthesis, nitrogen fixation, enhancing calcification and infection prevention. Conversely, under conditions of environmental stress, certain microorganisms cause coral bleaching and disease. Stress responses and tolerance limits of corals are the result of complex interactions with their various symbionts, but the extent to which each member contributes to a particular trait is poorly understood. The viruses associated with corals have received little attention, and their diversity and functions in the ecology and evolution of corals are virtually unknown. We have started to explore the diversity of coral-associated viruses in a range of coral species on the Great Barrier Reef (GBR), in healthy and diseased/bleached coral tissues, and in laboratory cultures of Symbiodinium isolated from coral. Our results show that the viral assemblages of corals are highly diverse. GBR Symbiodinium cultures are targeted by three groups of viruses; a retrovirus-like virus of filamentous morphology, a virus with genetic similarities to a ssRNA virus known to infect free-living dinoflagellates and with an icosahedral morphology, and a large dsDNA virus also of icosahedral morphology. We found evidence for regulation of viral genes during a laboratory heat stress experiment on cultured Symbiodinium. I will discuss the diversity of GBR coral and

Symbiodinium viruses and new insights gleaned into the roles that viruses play in corals. http://www.findanexpert.unimelb.edu.au/display/person726007

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FISHERY MANAGEMENT IN A RISKY AND UNSTABLE ENVIRONMENT: A SPATIAL MODELING APPROACH APPLIED TO THE GIANT CLAM TRIDACNA MAXIMA IN FRENCH POLYNESIA (Abstract ID: 28078 | Poster ID: 620)

The giant clam Tridacna maxima has been largely overexploited in many tropical regions over the past decades, and was therefore listed in appendix II of the Convention of International Trade in Endangered Species (CITES) in 1985. In French Polynesia, several atolls harbor the world's highest stocks of giant clams in very shallow and accessible areas, but massive (natural) mortality events also occurred in some semi-closed atolls of Tuamotu's archipelago. These natural fluctuations of stocks complicate management recommendations. Here, we report on the use of a spatially explicit population dynamics model applied for one atoll (Tatakoto, Tuamotu's archipelago) affected by both fishing pressure and natural mortality events. Giant clam abundances, growth, mortality, recruitment, and fishing effort were estimated in situ and used to design a network of spatial planning units following an integrated approach. The spatially explicit population model then simulated future trends of T. maxima abundances following a stochastic approach and evaluated the best management strategies to optimize future stocks. In the risky and uncertain environment of Tatakoto atoll lagoon, abundances were a trade-off between recruitment and high mortality. Our results suggested that fishing effort had low impact on giant clam abundance compared to the natural fluctuation of stocks, but reducing fishing pressure through quotas was the most efficient management tool to increase resilience and accelerate the recovery of stocks after a massive mortality event.

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DEVELOPING COST EFFECTIVE METHODS FOR QUANTIFYING THE HABITAT BENEFIT OF WATERSHED RESTORATION (Abstract ID: 29440)

Since 2011, NOAA has funded watershed restoration projects on Culebra Island, Puerto Rico to reduce land-based sources of pollution (LBSP) discharged to coral reef habitats. However, due to budgetary constraints, performance based monitoring has generally been limited. NOAA's Restoration Center, in coordination with other NOAA line offices and independent scientists, developed a cost-effective multi-spatial and multi-temporal monitoring protocol to evaluate the performance of the LBSP management actions, inform adaptive management strategies, and better understand linkages of management actions to coastal habitat health. In 2014, monitoring was initiated to test this protocol and includes: crude modeling of pre- and post-restoration sediment loads, studies to quantify the sediment mass reduction at the management practices, establishing baseline metrics of nearshore water quality, seagrass health, and coral health. Preliminary results indicate that watershed restoration projects reduce sediment loads by 85% at-the-practice. Baseline nearshore water quality is dynamic, yet mean annual turbidity, water clarity, and chlorophyll a are correlated to known LBSP impairments. Furthermore, water quality indicators are correlated to metrics of seagrass and coral reef health. Comparisons of these results to similar watershed scale studies suggest that investments in low-cost long-term water quality and habitat quality monitoring could provide a cost-effective approach to evaluating linkages between LBSP management and coral reef health.

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REGIONAL ANALYSIS OF ACROPORA PALMATA POPULATION AND RESILIENCE DYNAMICS USING STOCHASTIC MATRIX MODELING (Abstract ID: 29569)

*A. palmata population* dynamics reveal important patterns of change in abundance and cover that cannot be realized by straightforward trend analysis. Using data collected between 2004 and 2011 in three primary (Florida, Curacao, and Jamaica) and three secondary (Virgin Gorda, Navassa, and Puerto Rico) locations across the Caribbean, we estimated rates of change and variability in population size using stochastic matrix modeling. The most striking difference we quantified was between Jamaica, where population size is projected to grow by 2% / y, and all other locations, where population sizes are projected to remain stable or decline. This is likely due to the recovery of the sea urchin *Diadema antillarum* on Jamaican reefs, where density (3.5 +/- 0.6 / m^2) is an order of magnitude greater than in the other study locations. We also discovered a distinct contrast in resilience dynamics. Florida and Curacao populations each weathered severe storms during the study period and the dynamics exhibited during the calm years -- 2%/y growth in Florida where severe storms are relatively frequent versus 4% /y decline in Curacao where severe storms are infrequent -- were fundamentally different from each other, suggesting that populations have varying degrees of resilience to storms. Characterizing *Acropora palmata*dynamics across space can help us design location-specific management criteria -- although the conservation goals (increase abundance and extent) may be common, techniques and expected outcomes should be different.

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DETERMINING THE EFFECTIVENESS OF WATERSHED MANAGEMENT ACTIVITIES TO REDUCE LAND-BASED POLLUTION ON WEST MAUI (Abstract ID: 28118)

As an approach to reduce the effects of land-based sources of pollution on coral reefs, the U.S. Coral Reef Task Force and NOAA's Coral Reef Conservation Program identified West Maui as one of two Pacific Region priority areas for the implementation of the Ridge-to-Reef management initiative. There are five priority watersheds in West Maui: Wahikuli, Honokowai, Kahana, Honokohua, and Honolua. This study summarizes work completed to establish a baseline against which to assess the effectiveness of future upland management activities aimed at reducing sedimentation stress to the adjacent coral reefs. Permanent, replicate coral community monitoring transects were established adjacent to seven drainages within the five priority watersheds. Benthic reef community structure and coral population demographic parameters, including percent cover, coral colony density, size class structure, and health condition data were collected. In addition, terrestrial sediment loading was evaluated by turbidity, sediment composition, and sediment accumulation data at a subset of sites. While this baseline assessment provides a framework to assess change over time, it also underpins the wide range in the overall health status and condition among adjacent coral communities in relation to land use, in addition to highlighting data and informational gaps. This information is a pivotal component of the watershed characterization process as it helps support decision-making regarding watershed restoration efforts aimed at reducing land-based pollution impacts to high-priority reefs.

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A MORPHO-FUNCTIONAL APPROACH IN CORALLINE ALGAE (RHODOPHYTA) TO UNDERSTAND NICHE PARTITIONING AND THEIR DIFFERENTIAL SENSITIVITY TO GLOBAL CHANGE (Abstract ID: 29512 | Poster ID: 282)

The capacity and efficiency of the photosynthetic tissue to absorb light are two key functional properties involved in the regulation of the amount of solar energy that can be transformed into organic carbon and the carbonate skeleton of the photosynthetic calcifiers. Their variation may explain how organisms adequate differentially to a changing environment, maximizing photosynthetic production and minimizing the costs of photodamage and repair. As part of a general analysis of the response of coralline algae to global change, we investigated the optical properties of three coral reef species representing the main coralline growth-forms: rhodoliths, articulated and crustose algae (CCA), in relation to basic structural and functional traits of the thalli. Rhodoliths and the CCA absorb light more efficiently than the articulated alga, and were more productive either per projected area, the former, or per dry mass the later. However, the larger capacity of the articulated algae to extend its light collecting area would explain why this growth-form is the most successful and productive in a wider number of habitats. In absence of a fixed substrate, under very high hydrodynamics or at low irradiance levels, the other growth-forms can compete more successfully with the articulated alga. Moreover, the larger respiratory demand of the articulated growth-form under elevated temperature, explains its particular sensitivity to global warming within a group with an already documented fragility.

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CORAL RESTORATION, PAST, PRESENT AND FUTURE TECHNOLOGIES (Abstract ID: 29682)

Coral restoration efforts historically, have evolved from reef stabilization, to the present active restoration methods using propagation nurseries to outplant reef organisms. This presentation will review the development of newer methods of active restoration, using corals produced under aquaculture propagation techniques for outplanting. Case studies of the commonly used branching coral, or Acropora species, for reef restoration will be

compared to some emerging technologies. New technologies for restoration of the massive reef building species will be presented with findings of accelerated growth, and the production of larger number of colonies than ever previously predicted. The potentials of this technology also allows for the repair and replacement of new living tissue on the surface of dead coral heads, makes this a new and novel technology. This technology is now possible at a rate and scale comparable to the majority of branching coral restoration projects. Future technologies of larger number of sexual recruits for restoration are having greater advances in the recent years and will provide the ability to do genetic crosses to produce more plantable materials and better selection and genetic diversity. Novel techniques that can enhance future resilience by accelerating growth to sexually mature sizes are being developed as new tools for reef restoration efforts that can utilize more resilient strains for restoration.

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IMPROVING THE UNDERSTANDING AND INFLUENCE OF INDIGENOUS FIJIAN FUNERAL PRACTICE ON CORAL REEF-SOCIO-ECOLOGICAL SYSTEMS (Abstract ID: 30080 | Poster ID: 601)

A majority of research on community based Marine Protected Areas (MPAs) has been on areas intended for conservation and reef restoration, for the purpose of food security. These are often larger in size and span more than two years. In Fiji, there are more than 400 community based MPAs as part of the successful Fiji Locally Managed Marine Area (FLMMA) network. However, what is little known and understood is the geographic spread, extent and frequency of community based MPAs that are established culturally following the burial of an indigenous Fijian. These funerary MPAs, although only established for 100 nights and small in area, could have influenced the establishment of larger, longer term community based MPAs in Fiji. More importantly, to know how this knowledge is utilized and built upon in community engagement and management of coral reef socio-ecological systems in Fiji. This paper is aimed at presenting preliminary findings on the above.

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A POSSIBLE ROLE FOR VITAMIN C IN CORAL CALCIFICATION (Abstract ID: 29670 | Poster ID: 26)

The biological components of the calcification process in coral reefs are poorly understood. Because calcification must involve the transport of molecules across cell membranes, we postulate that it could have similarities to transport mechanisms in vertebrates. We want to identify the specific membrane transporters underlying skeleton formation. As a model, we are using larvae from the ubiquitous Caribbean coral, Porites astreoides. Using Illumina RNAseq, we assembled a transcriptome and compared gene expression between swimming larvae and recently settled ones that had just started the calcification process. As expected, we identified many ion transporter, pump and channel that were upregulated in settled larvae. Surprisingly, the most upregulated transcript appeared to encode a Na-dependent vitamin C transporter (SLC23A). In vertebrates, SLC23A plays a vital role in bone morphogenesis where vitamin C is an essential cofactor for the collagen formation. In corals, collagen has been identified as a component of the skeleton's extracellular matrix. Using in situ hybridization, we showed that the P. astreoides SLC23A messages were expressed in regions adjacent to rapid skeleton formation. To confirm that the coral clone is indeed a vitamin C transporter, we expressed it in Xenopus oocytes and studied its activity using voltage-clamp. Preliminary data demonstrate that it induces a current that is activated by Na and vitamin C. This approach will help us better understand the molecular mechanisms underlying calcification and how they might respond to environmental change.

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THE IMPLEMENTATION OF RARE EVENTS LOGISTIC REGRESSION TO PREDICT THE DISTRIBUTION OF MESOPHOTIC HARD CORALS ACROSS THE MAIN HAWAIIAN ISLANDS (Abstract ID: 28437)

Predictive habitat suitability models are powerful tools for cost-effective, mathematically robust ecological assessment of the environmental drivers of species distributions. The aim of this study was to develop a predictive habitat suitability model for two genera (Leptoseris and Montipora) of mesophotic scleractinian corals across the main Hawaiian Islands. The mesophotic zone (30 - 180 m) is challenging to reach, and therefore historically understudied, because it falls between the maximum limit of SCUBA divers and the minimum typical working depth of submersible vehicles. Here, we implement a logistic regression with rare events corrections to account for the scarcity of presence observations within the dataset. These corrections reduced the coefficient error and improved overall prediction success (73.6% and 74.3%) for both original regression models. Predictions were translated to spatially independent habitat suitability maps of the main Hawaiian Islands at 25 x 25 m resolution. Our maps are the first of their kind to use extant presence and absence data to examine the habitat preferences of these two dominant mesophotic coral genera across Hawai'i.

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RETHINKING CORAL MICROBIOLOGY PARADIGMS: DESTABILIZATION VERSUS ALTERNATIVE STABLE STATES AS CRITICAL HALLMARKS OF STRESSED CORAL ECOSYSTEMS (Abstract ID: 28764)

Microbiologists have studied the structure and function of the bacteria and viruses associated with corals for decades. Our collective knowledge has revealed several important properties of the holobiont and how it responses to environmental perturbation. For example, a standard paradigm in the field is that stressors disrupt the normal patterns of host control, allowing for growth and production of pathogenic or opportunistic bacteria and viruses. These disruptions are most commonly conceptualized in terms of shifts between alternative stable states or the rise and fall of individual pathogens. Thus our studies of coral disease and dysbiosis have focused on evaluating whole community shifts or blooms of specific taxa. However, our recent work suggests that these approaches can miss some categories of community changes that occur in the microbiomes and viromes of hosts experiencing a variety of stressors, leading to the generation of false negatives. We present the hypothesis that many disturbances to the coral microbiome, especially those that promote opportunism, increase beta-diversity (sample to sample variation) of the microbiome and virome. This hypothesis will be discussed in light of data from coral and other marine hosts. We will present a meta-analysis of microbiome and virome data, to lend support for this hypothesis, including the analysis of a long term dataset where nutrients and algal cover were manipulated and temperature varied.
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SPATIO-TEMPORAL CHANGES IN CORAL PHOTOSYNTHETIC EFFICIENCY, REEF PRODUCTIVITY AND WATER TURBIDITY AT FLORIDA KEYS PATCH REEFS (Abstract ID: 28375)

Coral reef productivity is driven by light availability and depends in part on a complex set of chemical processes, biological diversity, the health of the coral community, and hydrographic regimes. We assessed the spatial and temporal variability of stony corals photosynthetic yields in relation to coral reef productivity and water turbidity in three sites in the Florida Keys. Two nearshore turbid patch reefs off Sugarloaf Key and Cheeca Rocks, and one outer reef tract by Crocker Reef where water is typically less turbid, were surveyed in May and October 2012, and May 2013. At each site, net ecosystem productivity (NEP) was measured within mesocosm enclosures, the photosynthetic efficiency of healthy corals was monitored with PAM fluorometry, and water quality parameters were measured with optical instruments. The photosynthetic efficiency was not significantly different among coral species or between seasons, but was different between sites. Corals at Crocker Reef had the lowest mean photosynthetic efficiencies (< 0.55) despite being located in the clearest water. The lowest NEP (< 0.02 g O2 m-2 15 min-1) was also found at this reef site. Diurnal variations in the effective yields were inversely related to PAR and reef productivity in all seasons and study sites. Results suggest that corals in near shore patch reefs might benefit from shading by turbid water or by higher chlorophyll a or particle (food) concentrations in the water column, which might help explain higher photosynthetic effective yields, productivity and live coral cover observed in these areas.
http://www.imars.usf.edu/

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CORAL TRIANGLE FISHERIES VULNERABILITY IN A CHANGING CLIMATE: SKIPJACK TUNA THERMAL SPAWNING HABITATS (Abstract ID: 29529)

We investigated projected sea surface temperature (SST) changes and their impacts on Skipjack tuna spawning habitat for the Coral Triangle Region (CTR, 12°S-22°N and 94°E-163°E). A comprehensive Skill Validation Assessment found the 5 best performing models for SST of 36 CMIP5 models that were then used as a multi-model aggregate. Monthly 1° SST multi-model aggregate projections under RCP 8.5 show that significant increases in SST as high as 2.8°C (mean value) will likely occur in the CTR by the end of the century. To these estimates of SST change, we applied three parameterizations of Skipjack tuna (Katsuwonus pelamis) spawning temperatures. The three spawning temperature parameterizations were: a) a square-wave function (SWF) derived from catch data with boundaries at 26°C and 30°C; b) a symmetric Gaussian function (SYF) derived from the SEAPODYM models, and c) an asymmetric Gaussian function (ASYF), that modifies the SEAPODYM curve in (b) to include the results of relevant physiological experiments. All three parameterizations show similar geographic patterns, with the amount of favorable spawning habitat decreasing throughout the central, equatorial CTR and increasing at higher latitudes. However, each of the three parameterizations shows marked differences in the modeled magnitude of change, with the ASYF showing a region-wide average decline of 66.1% in favorable spawning habitat between 2015 and 2100. These projected changes in tuna spawning habitats are likely to have important local and regional consequences for fisheries, food security, and livelihoods.

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MARINE CONSERVATION PRIORITIZATION IN 3D: ACCOUNTING FOR THE THIRD DIMENSION (Abstract ID: 30042)

Spatial conservation prioritization (SCP) is used to identify areas where conservation goals can be achieved more efficiently, and usually carried out in a two dimensional space. In an inherently three dimensional (x,y,z coordinates) space such as the ocean, this approach might not be the most efficient, as it results in the application of one type of management to an area of the ocean all the way from the surface to the bottom (or beyond). In this study we aim to develop a 3D approach which allows explicitly incorporating depth into SCP, so that vertical as well as horizontal spatial prioritization can be accomplished through conservation planning software. This approach has been developed using Marxan as the conservation planning software,by stratifying the ocean in different layers according to depths, and applying different techniques to prepare the input data such as 3D GIS. Its efficiency is assessed by comparing the resulting spatial conservation priorities with a typical 2D conservation planning. Preliminary results indicate that 3D SCP of marine biodiversity features can be more efficient, both in terms of cost and total area needed to achieve conservation objectives. This new approach could potentially allow protecting important biodiversity at specific depths, while allowing uses of the ocean that do not pose a threat to this biodiversity at other depths. Moreover, such a prioritization could prove important in adequately addressing the protection of presently under-represented marine ecosystems in the global MPA system such as pelagic and deep-ocean ecosystems.

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MULTIPL DRIVING FACTORS EXPLAIN SPATIAL AND TEMPORAL VARIABILITY IN CORAL CALCIFICATION RATES ON THE BERMUDA PLATFORM (Abstract ID: 27898)

Experimental studies have shown that coral calcification rates are dependent on light, nutrients, food availability, temperature and seawater &Omega$_{ar}$, but the relative importance of each parameter in natural settings remains uncertain. In this study we applied a Calcein dye as time indicators within the skeleton of coral colonies across the northern Bermuda coral reef platform and evaluated the correlation between seasonal average growth rates with temperature, light and seawater &Omega$_{ar}$ in an effort to decipher the relative importance of each parameter. We also placed small coral colonies in chambers and measured the instantaneous rate of calcification under light and dark treatments. The results showed that skeletal growth, whether hourly or seasonal, appeared highly sensitive to &Omega$_{ar}$. Using short-term light and dark incubations we show, however, how the co-variance of light and &Omega$_{ar}$ can lead to the false conclusion that calcification is more sensitive to &Omega$_{ar}$. For the seasonal data, we assessed the impact of the observed average differences in temperature (4.0℃), light (5.1 mol photons $m^{-2}$ $d^{-1}$) and &Omega$_{ar}$ (0.16 units) on coral calcification rates based on established relationships derived from laboratory studies and found that they could account for approximately 44&percent, 52&percent and 5&percent, respectively, of the observed seasonal change of 81±14 mmolCaCO3 $m^{-2}$ $d^{-1}$.

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STRESS RESPONSE OF GASTRODERMAL PRIMARY CELL CULTURE FROM THE TEMPERATE SYMBIOTIC CNIDARIAN, *ANEMONIA VIRIDIS*(Abstract ID: 28345)

Development of cnidarian primary cell culture would allow progress on the environmental and biomedical fields. Primary cell cultures from tentacles of the temperate symbiotic sea anemone, *Anemonia viridis*, have been recently made available in our laboratory. Cnidarian primary cell cultures represent a new biological model relevant to investigate molecular and cellular processes involved in the establishment and maintenance of the cnidarian-dinoflagellate symbiosis and to evaluate the effect and the responses of environmental stresses. We characterized *A.viridis*primary cell cultures by measuring cell growth rate and cell viability during maintenance and propagation of 31-day cultures. Primary cell cultures exhibited a maximal cell growth rate (15 fold increase of cells) during the first two weeks followed by a decrease till the end of the kinetics. Cell viability was constant and high (around 80%) until the end of 31-day culture. Molecular analyses of the expression of tissue specific markers, i.e. markers of epidermal or gastrodermal cell layer and undifferentiated cells, allowed us to confirm the establishment of *A. viridis* differentiated cultured cells from gastrodermal origin. The cellular responses to environmental stresses and to symbiosis constraints were then investigated by this in vitro tool. The effect of thermal and oxidative ($H_2O_2$) stresses on cell viability, cell growth and on the expression of stress markers during a 15-day culture confirms the intrinsic phenotypic plasticity of the gastrodermal cnidarian cells.

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MECHANISMS FACILITATING THE TROPICALISATION OF TEMPERATE ALGAL FORESTS IN JAPAN AND AUSTRALIA (Abstract ID: 29122)

The southeastern coasts of Japan and Australia are climate change hotspots, where ocean warming is occurring 2-3 times faster than the global average and leading to the range expansion of tropical species into temperate regions. These changes are profoundly altering ecological communities, causing communities to shift from economically important kelp forests to turf and/or coral-dominated systems. Here, we investigate the role of herbivory in mediating these observed changes. In eastern Australia, we use a ten-year (2002-2012) video dataset encompassing a 0.6°C increase in sea surface temperature to quantify patterns of kelp-herbivore interactions in a tropical-temperate transition zone. We found a marked increase in herbivory as kelp abundance declined from 70% reef coverage in 2002 to full disappearance from 2010 and onwards. During this time, fish communities from sites where kelp disappeared became increasingly dominated by tropical and herbivorous species. Fish surveys and experimental feeding assays in both Japan and Australia identified a small number of species capable of direct consumption of temperate algae. However, subtropical grazing surgeonfish increased most notably in sites where kelp has disappeared, suggesting this functional group plays a pivotal role in maintaining communities denuded from kelps, presumably via the consumption of kelp recruits. Our results indicate that range expansion of herbivorous fish pose a significant threat to kelp dominated ecosystems and the economically important communities they support.

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DIFFERENT RATES OF RECOVERY ON CORAL FECUNDITY AND SETTLEMENT SUCCESS ON SINGAPORE REEFS (Abstract ID: 28584)

Coral replenishment is a keystone process for reef resilience, particularly in recovery from localized disturbances that cause extensive mortality to adult colonies on a reef. Reef replenishment is dependent on reproductive fecundity as well as successful recruitment, and both processes are known to be highly sensitive to environmental conditions. However, a majority of studies focus on one or the other, with few investigating differences in influential factors. In Singapore coral reefs, recovery following the 2010 mass coral bleaching event was notably more rapid for coral fecundity than for settlement. High levels of inter-specific variation was also observed in recovery rates of coral fecundity, and these were associated with differential responses to key water quality parameters. Recovery of settlement intensity was severely lagged, with noticeable settlement of other taxa only in 2015, being previously dominated by pocilloporids. Recent settlement success is shown to be associated with improvements in water clarity, which was not a significant factor for fecundity. This provides an increased understanding of the long term impacts to reefs following habitat alteration. Sustainable resource management for successful reef replenishment must therefore identify and address both sets of bottlenecks.

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IMPACT OF TEMPERATURE AND PH PREDICTED FOR THE 22TH CENTURY ON ENERGY METABOLISMS AND SHELL GROWTH OF THE GIANT CLAM *TRIDACNA MAXIMA* (Abstract ID: 28237 | Poster ID: 367)

One of the most emblematic organisms of the Polynesian lagoons is the giant clam, *Tridacna maxima*. Used for food and art since millenniums it takes on a strong patrimonial value for the Polynesian society. Otherwise, giant clam populations support since a couple of years the emerging, but promising, economy of live specimens production for the aquarium trade. Such as many other reef organisms, giant clams are today confronted to the effects of global change and can suffer from unexplained mass mortalities events putatively induced by abnormally high seawater temperature. Despite its strong interest, its response to the two most alarming threats linked to global change (i.e., ocean warming and ocean acidification) is still poorly known. To partly address this lack we conducted a series of experiments aiming to reproduce temperature and pH predicted to occurred in the French Polynesia lagoon waters at the horizon of the 22th century (RCP 4.5). In this purpose 96 giant clams were randomly distributed in 16 40 L tanks and exposed for 2 month to the following conditions: i) 29.2°C, pH 8.2 (control); ii) 30.7°C, pH 8.2 (thermal stress only); iii) 29.2°C, pH 7.8 (acidification stress only); iv) 30.7°C, pH 7.8 (thermal and acidification stress). To quantify their responses to each treatment, respiration rates and shell growth were measured at the individual level. At the microscopical scale the effects on the shell microstructure were evaluated by scanning electron microscopy. The data are currently under acquisition and will be presented.

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RECURRENT BLEACHING INDUCING THERMOTOLERANCE INCREASES: A DIVE INTO THE HOLOBIONT ADAPTABILITY THROUGH (META)GENOMIC AND EPIGENOMIC MECHANISMS (Abstract ID: 28242)

Coral reefs worldwide are declining under the pressure of global warming. This alarming state is mainly due to coral bleaching and the subsequently induced mortalities. However, in some particular cases of low human-impacted reefs, coral thermotolerance is seemingly increasing in response to recurrent thermal bleaching episodes. It is known that coral's resistance to thermal stress is the result of individual capacities of both holobiont partners, as well as their reciprocal interactions. Yet, the underlying mechanisms remain to be deciphered. In an effort to better characterize them, we conducted a multiscale integrative study, combining genome-wide transcriptomic, (meta)genomic and epigenomic approaches on coral samples from the same colony of *Pocillopora damicornis* (Indonesia). Coral nubbins were subjected to one, two or three ecologically realistic episodes of thermal stress inducing bleaching. After each consecutive bleaching event followed by a year of resilience, we observed a clear and significant increase in thermotolerance. This phenotypic change was associated with a drastic increase of the plasticity at the transcriptomic level (RNA-seq approaches). This transcriptome remodeling was correlated with the observation of genomic (copy number variations) and epigenomic (methylome) variations. Our results suggest that rapid adaptation of corals to heat stress is possible and that molecular markers for thermotolerance could be developed.

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ANNUAL HOLOTHURIAN-MICROORGANISM INTERACTIONS UNDER DIFFERENT IPCC *P*CO2-TEMPERATURE SCENARIOS (Abstract ID: 29255)

*Holothuria atra*, one of the most abundant Holothurian species on tropical Indo-Pacific reefs, has the ability to turnover carbonate sediments, potentially contributing to the calcium carbonate budget by changes in total alkalinity and alkalinity derived from the production of Total Ammonia Nitrogen (TAN). Sediment microbes also have the potential to alter sea water chemistry through the dissolution and recycling of nitrogen. We tested the relative roles of microbes and sea cucumber (SC) on seawater chemistry under present day and projected representative carbon pathways (RCP4.5 & RCP8.5) in conditions appropriate to southern GBR for winter and summer. Our results showed that over winter, the animals had no significant impact on sediment decalcification; with physical and/or microbial bioerosion leading to elevated rates of sediment dissolution under RCP8.5 warming and acidification. Likewise, SC had no influence on TAN uptake that was significantly greater by night irrespective of scenario. During summer, there were trends for greater decalcification under RCP8.5, during nighttime and in the presence of SC, however, these were non-significant. TAN production significantly increased in the presence of SC by day and by night, and a greater TAN uptake was shown in their absence during nighttime. These results suggest that on an annual basis, regardless the effects on TAN production by SC, the main driver for calcification/decalcification in future reefs will be changes in the abundance and composition of the communities of microorganisms within the sediments.

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MODELING SPATIAL DISTRIBUTIONS OF MULTIPLE ESA SPECIES USING A MULTIVARIATE BAYESIAN FRAMEWORK (Abstract ID: 28868 | Poster ID: 697)

Management decisions for species and place-based conservation increasingly reference probabilistic spatial models of species distributions. For coral species listed under the U.S. Endangered Species Act (ESA), the best available scientific data needs to be utilized, yet different field surveys can vary widely in spatial and temporal effort, and ESA species can be quite rare. We predict joint spatial distributions of multiple Atlantic/Caribbean coral species including ESA species using generalized joint attribute models, a multivariate Bayesian framework. This approach uses inference and prediction for jointly distributed responses that account for a lack of independent occurrence of different species, accommodate multiple types of input data, and account for varying effort and zero inflation. We show spatial models for multiple coral species of abundance and partial mortality using data from multiple discrete surveys, including NOAA's National Coral Reef Monitoring Program, in the Dry Tortugas FL, the US Virgin Islands, and Flower Garden Banks National Marine Sanctuary. Predictive model maps show joint distributions for abundance and partial mortality of corals as related to environmental predictors derived from high-resolution bathymetry, as well as with thermal stressors and wave energy. Increased information on species distributions and environmental drivers can help guide conservation actions, restoration planning (e.g. selection of potential outplanting sites) and identify locations of potential species vulnerabilities to environmental stressors.

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COLD WAR IN THE TROPICS: ALLELOPATHIC INTERACTIONS BETWEEN THE BROWN ALGAL GENUS LOBOPHORA (DICTYOTALES, PHAEOPHYCEAE) AND SCLERACTINIAN CORALS (Abstract ID: 29313 | Poster ID: 281)

The brown algal genus Lobophora is an important benthic component of tropical coral reefs. Members of this genus are commonly observed in close contact with scleractinian corals and have been considered responsible for negative effects on the latter. Allelopathy has been recently suggested as a mechanism by which Lobophora may outcompete corals in damaged reefs. We performed in situ bioassays testing the allelopathy of crude extracts and isolated compounds of several Lobophora species, naturally associated or not with corals, against four scleractinian corals in New Caledonia. Our results showed that, regardless of their natural association with corals, organic extracts from species of the genus Lobophora are intrinsically capable of bleaching some coral species upon direct contact. Additionally, three new C21 polyunsaturated alcohols named lobophorenols A-C were isolated and identified. Significant allelopathic effects against Acropora muricata were identified for these compounds. In situ observations in New Caledonia, however, indicated that while allelopathic interactions are likely to occur at the macroalgal-coral interface, Lobophora spp. rarely bleached their coral hosts. These findings are important toward our understanding of the importance of allelopathy versus other processes such as herbivory in the interaction between macroalgae and corals in reef ecosystems.

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ENERGETIC RESOURCE ALLOCATION FOR REPRODUCTION IN TWO MEDITERRANEAN GORGONIANS WITH DIFFERENT REPRODUCTIVE STRATEGIES: SURFACE VERSUS INTERNAL BROODERS (Abstract ID: 27839)

The present study investigates the energetic investment in reproduction and the potential energetic allocation from parental colonies to larvae for two gorgonians characterized by different reproductive strategies: Corallium rubrum (internal brooder) and Paramuricea clavata (external brooder). Quantification of sexual products and biochemical composition (lipid content and free fatty acid (FFA) content and composition) were used to examine the parental energetic investment and demand in reproduction. Results showed that the energetic cost is mainly due to the reproductive activity (i.e. gametogenesis and spawning). The two species displayed different life history strategies (with C. rubrum investing less energy in reproduction than P. clavata) and sensitivity to environmental conditions (being P. clavata more sensitive than C. rubrum). The quality of energetic reserves transferred from maternal colonies to larvae was analysed by comparing their FFA composition. C. rubrum showed a similar FFA composition in maternal colonies and larvae, whereas P. clavata transfers low amounts of energy to oocytes. FFA composition suggests that C. rubrum larvae have the highest dispersal and/or crawling behaviour capacity compared to P. clavata. This shows how FFA analyses can get insight into the activity rates, the dispersal and recruitment capability of different gorgonian species. Observed differences in energetic investments may affect the recovery dynamics of these species after major disturbances, with C. rubrum strategy mainly focused on resistance, while P. clavata on resilience.

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UNRAVELING INSHORE-OFFSHORE MACROBENTHIC DIVERSITY PATTERNS IN RED SEA CORAL REEFS (SAUDI ARABIA) REVEALED BY BARCODING TOOLS (Abstract ID: 28994)

Understanding patterns and processes that drive the structure of coral reefs communities is essential for biodiversity conservation. Cross-shelf biodiversity gradients (inshore-offshore) have been described for fish, corals, and macroalgae as a response to stressors including sedimentation and pollution. However, the influence of such gradients on cryptic invertebrates, such as small crustaceans, mollusks, and echinoderms, which represent the vast majority of coral reef diversity, is largely unknown. The high diversity, small size and lack of taxonomists have been limiting our knowledge about these cryptic assemblages. Besides, taxonomy based on their morphology is difficult and time-consuming with many species yet to be described. This study undertakes a quantitative survey of invertebrate communities (>2mm) collected using a standardized approach (Autonomous Reef Monitoring Structures (ARMS) across an inshore to offshore gradient on the Saudi Arabian coast of the Red Sea. DNA barcoding of the mitochondrial COI gene was used to supplement morphological identifications. Preliminary results showed that most of the COI sequences do not match any reference barcodes in public libraries (GenBank and BOLD). In addition, the rarefaction curves did not plateau, suggesting that this study was unable to fully characterize the diversity in the region. Community composition changed from inshore to offshore and was significantly correlated with the type of substrate. Inshore reefs are inhabited by taxonomical groups that differ substantially from the remaining reefs sampled.

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IMPROVING THE FISH-BE MODEL TO INFORM MARINE PROTECTED AREA NETWORK DESIGN (Abstract ID: 28923 | Poster ID: 649)

Numerous guidelines and tools have been developed to provide guidance in designing networks of marine protected areas (MPA). Some of these tools have been able to include other objectives apart from biodiversity conservation (i.e. minimizing loss or maximizing representation of species and habitats), such as connectivity, fisheries management, and threats management. However, these tools are either not spatially explicit or have only integrated and modeled a few spatial attributes. Here we present an initial version of the spatially explicit Fisheries Information for Sustainable Harvest – Bioeconomic model, which can quantify fish standing stock biomass given varying levels of habitat quality and complexity, larval connectivity, fishing pressure, and sedimentation. This new version is a fish population model with a spatial domain composed of a uniform sized grid with cells. The model runs simultaneously in each cell, with the standing stock biomass documented at each time step for each cell and the entire grid. The model can be used to map and visualize potential benefits of MPAs on fisheries productivity, and guide the design of networks by identifying the size and locations of MPAs. Moreover, the tool can also be used for marine spatial planning as decision-makers and resource managers can use it for developing different scenarios on the effects of various and combinations of threats and other resource-use activities on fisheries productivity.

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ASSESSING FUNCTIONAL DIVERSITY: FROM TRAITS TO MULTIDIMENSIONAL INDICES (Abstract ID: 28355 | Poster ID: 507)

Trait-based approaches are increasingly applied in community ecology to assess spatial patterns and temporal trends of functional diversity to ultimately understand how human impacts affect ecosystem functioning. Several methodological frameworks have been proposed to compute the diversity of traits values present in a species assemblage and the similarity of traits values between several assemblages. However, methodological choices could have deep implications on the results since some approaches have biases (e.g. functional dendrogram) and because indices have different properties (e.g. accounting for relative biomass of species or only for their traits values). Here we present user-oriented guidelines for each of the three steps to compute functional diversity: (1) selecting a set of traits and measuring them in a set of species assemblages, (2) building a multidimensional space of high quality to place all the species according to their respective traits values, (3a) computing complementary indices describing the facets of the distributions of species and of their biomass in this space and/or (3b) computing complementary indices of functional dissimilarity between assemblages. For each of the two last steps, we list a set of R packages and functions already available.

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INTEGRATED WATERSHED MANAGEMENT AND GREEN INFRASTRUCTURE IN PUERTO RICO (Abstract ID: 29400)

Land-based sources of pollution (LBSPs) represent a significant threat to coastal ecosystems in Puerto Rico. This oral presentation for the ICRS' session #73B: Partnerships for Achieving Effective Resource Outcomes on Coral Reefs – Partnerships with and Among Communities and Stakeholders will describe how to develop effective integrated watershed conservation management plans and effective local restoration efforts led by the non-profit organization Protectores de Cuencas, Inc. (PDC) utilizing low cost green infrastructure. This session will showcase a list of green infrastructure demonstration projects implemented in Guánica, Vieques, Cabo Rojo, Yauco, Culebra and the Northeast Reserves within the archipelago of Puerto Rico. The presentation will be given by PDC's Director, Roberto Viqueira. The session will last approximately 30 minutes. Roberto's presentation will promote integrated watershed management as an effective approach for Puerto Rico and the Caribbean region, as well as provide concrete restora-

tion solutions to LBSPs for marine and coastal ecosystem protection.
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ECOLOGY OF HYBRIDISING ANGELFISHES: LOW ABUNDANCE AND NICHE OVERLAP PROMOTE HYBRIDISATION (Abstract ID: 29097)

Hybridisation has traditionally been considered rare in Coral reef fishes. However, recent studies have revealed that hybridisation is common. The angelfishes (Pomacanthidae) have the greatest proportion (~30%) of hybridising species with 26 species reported to hybridise. The aim of this study is to test the theory that low abundance and niche overlap are important factors promoting hybridisation. This theory has been developed based on terrestrial studies and here we test its generality in the marine environment by examining hybridising angelfishes at Christmas Island (Indian Ocean). We studied three species of pygmy angelfish (Centropyge flavissima, C. eibli and C. vroliki) and their hybrids to address three objectives: (1) determine temporal and spatial patterns in abundance and whether these patterns are linked to environmental factors; (2) to test for overlapping patterns in habitat use; (3) to test for overlapping patterns in diet. C. flavissima was abundant, whereas C. eibli, C. vrolikii and all hybrid combinations were consistently rare. All parent species and hybrids used overlapping habitats and achieved highest abundance at sites with a high reef aspect (vertical reef walls), high cover of turf algae and low wave exposure. Parent species and their hybrids also had similar diets that were comprised of a mix of green, red and brown algae. Thus, rarity of parent species and niche overlap help promote hybridisation in angelfishes at Christmas Island. This study provides empirical support that hybridisation in reef fishes conforms to terrestrial-based theories.

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COMPARISONS OF SYMBIOTIC DINOFLAGELLTE COMPOSITIONS OF CORALS IN THE UPPER GULF OF THAILAND AND IN CORAL HATCHERY: IMPLICATION FOR CORAL TRANSPLANTATION PLAN (Abstract ID: 30095 | Poster ID: 492)

Symbiotic dinoflagellates (Symbiodinium) in corals in the upper Gulf of Thailand and in the coral hatchery were investigated for establishing suitable coral transplantation plan. We performed genotyping of symbiotic algae of 5 coral species (three Acropora species, Pocillopora damicornis, and Platygyra sinensis), which have been propagated through sexual reproduction in the hatchery and used for coral transplantation in our research area. The results showed that clades C and D were dominant in all coral species examined in this study, and the compositions of these clades showed some variations among species and among coral specimens in the natural reefs and the coral hatchery. Considering the general notion that clade D is more tolerant to heat stress than clade C, selecting cultured juvenile corals possessing clade D in the hatchery may be better for future coral transplantation.
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EFFECT OF LOWER PH ON EARLY DEVELOPMENT AND SETTLEMENT OF CORALS, ACROPORA MILLEPORA AND POCILLOPORA DAMICORNIS (Abstract ID: 29969 | Poster ID: 379)

The effects of low pH on the early development and settlement of two coral species, Acropora millepora and Pocillopora damicornis were investigated. Three different pH treatments (pH = 7.6, 7.9, and 8.1) were used. The results showed that the lower pH levels caused significant decreases of fertilization rates of A. millepora. The low pH also led to abnormalities of embryonic and larval developments of both coral species. In addition, there were significant differences in the settlement rates of A. millepora and P. damicornis larvae between pH treatments ($p < 0.05$). The decrease in pH levels caused a strong decline in larval settlement rates. At pH 7.6 and 7.9, all larvae were unable to complete metamorphosis, and metamorphosis delay was observed. From this study, strong negative effects of pH reduction on coral larvae were observed.
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CORAL TRANSCRIPTOME RESPONSES TO THE LUNAR CYCLE (Abstract ID: 27967)

The lunar cycle controls the timing of broadcast spawning in reef building corals, with most species spawning on a specific evening or two following a full moon. Very little is known about how corals perceive the lunar cycle and translate this information into precise reproductive timing. To increase our understanding of this process we undertook a long term analysis of transcriptome dynamics over the lunar month preceding spawning in Acropora humilis. Corals were sampled under two different regimens. In the first corals were transplanted to flow through tanks with a normal daily light cycle, and an artificial lunar cycle from a broad spectrum light. The second set were collected from the field. Samples were taken at noon and at midnight at multiple points of the lunar cycle. RNA was isolated from samples, libraries generated, and NGS sequencing performed. Analysis of the results indicates that many biological processes change over the course of the lunar month, including skeletal deposition, energy metabolism, and mRNA translation. There are also effects on genes associated with circadian clocks and neurohormones. It is possible that shifting cycles of clock genes may allow corals to interpret lunar phases and contribute to controlling reproductive timing.

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COMPARATIVE STUDY ON CORAL REEF RELATED FISHERY RESOURCES AT THE AREAS OF VIETNAM REPRESENTATIVE FOR WESTERN SOUTH CHINA SEA AND THE EASTERN GULF OF THAILAND (Abstract ID: 28032)

Coral reef related fishery resources were studied at 4 reef areas during 2010 - 2014, using brainstorming consultations with local experienced fishermen. The calculated yields per square kilometer per year ranged greatly among areas, lowest in Ninh Hai waters (19 tons) to highest in Tho Chu islands (200 tons). Studied reefs supported important fisheries with the calculated revenues ranging between 500 - 800 thousands USD per area. Collection of juveniles for cage culture also contributed high revenue for fishermen, around 1 and 1,5 millions USD from lobster juvenile in Ninh Hai waters and Nha Trang bay respectively, and approximately 600.000 USD from grouper juvenile in Phu Quoc islands. The calculation suggested a discussion about uncertainty in making reliable yield estimation, considering reef area calculation and fishing grounds.In addition, the recorded data indicated differentiae of reef resources at the regional and areal scale. The resources in areas of the Gulf of Thailand were characterized by dominance of fin fish in which fusiliers contributed around 50% of total production and diversity of deep water mollusks. Meanwhile, resources in the western South China Sea varied among areas, considering the presence of lobster and Tripneustes sea urchin, both of which were absent in the eastern Gulf of Thailand. Sustainability of reef fisheries in study areas was also concerned with consideration about serious reduction of predator species and over-exploitation of some other resources under continuous pressures of over-capacity, taking account of recent development of night diving for fishing in almost reef areas and illegal fishing at remote reefs
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HIGH-THROUGHPUT METABOLOMICS IDENTIFIES SPECIES- AND HABITAT-SPECIFIC METABOLITES IN CORALS (Abstract ID: 28925)

Untargeted metabolomics such as Liquid Chromatograhy-Mass Spectrometry (LC-MS) has the potential to rapidly and quantitatively fingerprint biological states and identify key metabolites in biological processes yet it has rarely been applied to corals. Here, we first quantify variation from multiple experimental sources such as extraction procedures and within colony variation demonstrating the reproducibility of LC-MS coral metabolomics. LC-MS was then used to compare the metabolomes of the shallow-water scleractinian Acropora palmata and 4 species of deepwater coral including a scleractinian, an

octocoral, and two anthipatharians. As expected, clear species-specific differences were detected. The largest difference was between shallow and deepwater taxa likely due to the presence of Symbiodinium sp. in A. palmata. To evaluate the potential of LC-MS to detect ecologically relevant, within-species differences, colonies of Callogorgia delta were collected near and far from areas of natural hydrocarbon seepage in the deep Gulf of Mexico. Colonies growing near seeps had d13C and d15N stable isotope values reflecting input of seep derived organics and the metabolome of seep-influenced colonies differed significantly from those that were not seep-influenced. Characterization of metabolites driving species and habitat differences is underway. These experiments lay the groundwork for joint analyses of metabolomic, proteomic and transcriptomic data that may yield unprecedented insights into the molecular stress response of corals.

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THE GENETIC BASIS OF CORAL IMMUNITY AND DISEASE RESISTANCE (Abstract ID: 28089)

The global rise in coral epizootics pose a serious threat to coral reefs, yet little is known about the genetic basis of coral immunity and disease resistance. Here we use transcriptome-wide RNAseq data to profile the immune response of endangered Caribbean staghorn coral *Acropora cervicornis* infected with White Band Disease (WBD), and then compare disease resistant and susceptible staghorn corals to identify the genetic underpinnings of disease resistance. WBD infected corals exhibited significant changes in gene expression across 4% of the coral transcriptome, primarily at genes associated with macrophage-mediated pathogen recognition, phagocytosis, apoptosis and the allene oxide pathway. The strong up-regulation of genes in the allene oxide pathway suggests its importance in coral immunity. Comparisons between disease resistant and susceptible corals identified constitutively expressed genes underlying disease resistance that are independent from the immune response associated with disease exposure. Genes involved in RNA interference-mediated gene silencing, including Argonaute, were up-regulated in resistant corals, whereas heat shock proteins (HSPs) were down-regulated. Up-regulation of Argonaute proteins indicates that post-transcriptional gene regulation plays a key role in coral disease resistance, whereas the down-regulation of HSPs in disease resistant staghorn corals may confer a dual benefit of disease and thermal resilience.

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EXPLORATION AND CHARACTERIZATION OF MESOPHOTIC REEFS OF THE FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY AND NEIGHBORING BANKS IN THE NORTHWEST GULF OF MEXICO (Abstract ID: 29419)

The Flower Garden Banks National Marine Sanctuary (FGBNMS) and adjacent banks in the Northwest Gulf of Mexico (NWGOM) exhibit unique and extensive shelf-edge coral communities. Using remotely operated vehicle (ROV)-based high definition imaging, we conducted 299 stratified random quantitative 100 m phototransects to characterize mesophotic reef habitats and fish communities on East and West Bank within FGBNMS as well as McGrail, Bright, and Geyer Banks lying east of the sanctuary. Benthic community composition differed significantly among habitat types across vertical zones. While Scleractinian corals comprised 66-75% of benthic cover on coral caps of East and West Bank, these shallower habitats account for only ~1% of the total FGBNMS area. Mesophotic communities (46-104 m) in the FGBNMS and adjacent banks were dominated by Scleractinians (14 species), black corals (*Antipathidae*, *Aphanipathidae*), and gorgonians-*Plexauridae*, *Ellisellidae*, *Primnoidae*). Extensive macroalgal overgrowth was observed at both McGrail and Bright Banks from *Sargassum spp.* and*Codium sp.* , respectively. Habitat partitioning among grouper and snapper families was distinct with few species occupying both shallow and mesophotic depths within FGBNMS. The results of this study and others indicate that mesophotic coral habitats in the NWGOM are more extensive and ecologically important than previously known, particularly with respect to supporting biologically diverse faunal assemblages and commercially important fish communities.

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REGENERATION IN CORALLIMORPHARIA (Abstract ID: 28833)

Corallimorpharia species, in the phylum Cnidaria, regenerate after fragmentation in approximately 14 days. They are closely related to Scleractinia, but are easily maintained in the laboratory and possess the potential to be a model for aspects of coral physiology and immunity. Our goal is to choose a corallimorpharian species and the conditions that allow for the fastest regeneration to be used in future research. This project examined the impact of intrinsic and extrinsic factors on regeneration. Intrinsic factors included the comparison of 3 species, representing 3 different genera, as well as small (<5 $cm^2$) versus large (>5 $cm^2$) initial polyp size. Extrinsic factors included light intensity (50–100, 150–200 and, 250–300 $\mu mole/m^2/s$) and feeding (starved or fed 1, or 2x/week). Individuals were fragmented and the surface area was measured over time using ImageJ to obtain a regeneration rate for each treatment. Zooxanthellae density was measured with the use of a haemocytometer. As there is a lack of studies describing the cellular processes during coral regeneration, the process of regeneration using light microscopy was also described over a 2-week period following fragmentation. This work will create a basis for future research on experimental pathology and immunology of coral disease, effects of environmental impacts on regeneration and regeneration mechanisms.

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INTERRELATION AMONG FOOD WEBS IN MANGROVE CREEK, SEAGRASS BED AND ADJACENT REEF LAGOON IN ISHIGAKI ISLAND, JAPAN (Abstract ID: 28606 | Poster ID: 428)

The organic carbon source derived from mangrove and seagrass bed is an important food source in the aquatic food web of coastal ecosystems. The inter-link between mangrove and seagrass as well as their roles in coastal aquatic food web depend on the ecosystem structure and the morphology of the coast. At Fukido estuary, Ishigaki Island, southern Japan, both mangrove creek and seagrass are conspicuous and often connected to the adjacent reef lagoon by tidal cycles. The distance between each habitat is less than 500 m, therefore the food source is usually mixed due to organisms' migration during ontogenesis in their life cycle and tidal force. To elucidate the main source of food derived from mangrove or seagrass area and transfer to higher tropic level, we analyzed the natural stable isotopes of carbon and nitrogen and their ratios in primary producers and consumers collected from mangrove and seagrass area. The isotopic evidence showed that the primary producers from mangrove has $\delta^{13}C$ values of -28.3 to -24.4 ‰, compared to the -21.9 to -9.9 ‰ values of samples collected in seagrass bed. The stable isotope signatures of consumers showed that their diets derived mainly from mangrove than seagrass area. $\delta^{13}C$ signal showed that juvenile reef fishes depended more on mangrove for food and adult fishes depended more on reef lagoon. This result showed that mangrove area is an important nursery for reef fishes.

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'REEF RECOVERY PLANS' FOR THE GREAT BARRIER REEF MARINE PARK-MANAGING LOCAL PRESSURES IN A GLOBAL CONTEXT (Abstract ID: 28971)

The Great Barrier Reef is in decline and the outlook for the ecosystem has been assessed as 'poor'. These declines are driven by a range of pressures, primarily climate change, degraded water quality, coastal development and some fishing activities. These pressures operate at a range of scales from global to local. The Great Barrier Reef Marine Park Authority is working with industries and communities to develop 'Reef Recovery Plans' to address local pressures at a local scale. These plans are intended to complement the catchment-based 'Water Quality Improvement Plans' to deliver a holistic catchment to Reef approach to local scale problems. The local pressures to be addressed include crown-of-thorns starfish outbreaks, localised unsustainable fishing, anchor damage, and marine debris. There is also a focus on protection and restoration of coastal ecosystems that support healthy marine environments. Reef Recovery Plans will include a mixture of regulatory mechanisms (such as Marine Protected Areas and fisheries management), and a voluntary, co-operative stewardship approach. This approach necessitates active partnership between Traditional Owners, government (at all levels), industry (especially tourism, fishing, and ports), and the community (recreational users, conservation). We expect that effectively addressing catchment and marine pressures at the local scale will help maintain the resilience of the ecosystem in the face of global pressures.

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THE REEF RESILIENCE NETWORK: TRAINING MANAGERS IN MMA DESIGN FOR FISHERIES AND BIODIVERSITY OBJECTIVES (Abstract ID: 29834)

The Reef Resilience Network connects coral reef managers and practitioners with information, experts, and resources to innovate, accelerate, and leverage solutions for improved global coral reef health and restoration of reef fisheries. More specifically, the Network provides: access to the latest science and management strategies; platforms for managers, practitioners, and experts to share ideas, experiences, and expertise; and training combined with seed funding to launch necessary education, monitoring, and threat abatement projects. In partnership with experts an online and in person training has been developed and piloted to build capacity for coral reef and coral reef fisheries managers to design and implement MMAs for fisheries and biodiversity objectives. The training includes information on design criteria and activities to help managers put scientific concepts into practice for their site. Skill building in communication and facilitation of stakeholders is also provided in order to increase the participant abilities to effectively implement the complex process of MMA designation on the ground. This presentation will provide an overview of the online training lessons, in-person training agenda and lessons learned.
http://www.reefresilience.org/online/

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CHARACTERIZATION OF MESOPHOTIC BENTHIC COMMUNITIES IN THE NORTHWESTERN HAWAIIAN ISLANDS (Abstract ID: 28927 | Poster ID: 328)

Historical surveys to characterize the marine biodiversity of the Northwestern Hawaiian Islands (NWHI) have largely focused on shallow (<30 m) or deep (>300 m) waters, with intermediate depths being largely ignored. This intermediate zone hosts mesophotic coral ecosystems (MCEs), which are notoriously undersurveyed worldwide and particularly in remote locations like the NWHI. Since 2012, annual expeditions have focused on systematically characterizing the mesophotic (50-90 m) biodiversity in the NWHI using mixed-gas technical diving. As part of these efforts, the bethic flora and fauna was surveyed using photoquadrat images taken along belt-transects, in combination with specimen collections that were identified by taxonomic experts. Benthic communities were largely dominated by macroalgae and crustose coralline algae, with hermatypic corals and other invertebrates generally covering less than 2% of substrates. Additionally, benthic communities in the NWHI exhibited latitudinal patterns, with linear decreases in coral cover and linear increases in macroalgal cover along a latitudinal gradient (23-28º N). Finally, benthic communities were almost exclusively composed of species that are native to the Hawaiian Archipelago, with the featherduster worm (Sabellastarte spactabilis) being the only non-indigenous species recorded among the over 200 benthic species documented during our surveys. These results underscore the importance of protecting the unique biodiversity of this region using the highest conservation measures available.

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POTENTIAL ROLE OF DIMETHYLSULFONIOPROPIONATE IN BLACK BAND DISEASE ETIOLOGY AND PERSISTENCE (Abstract ID: 29784)

Dimethylsulfoniopropionate (DMSP), an abundant source of sulfur and carbon in the marine environment, can be metabolized by bacterial genera found in coral microbial communities. DMSP is produced by the coral holobiont, and may be involved in coral health and disease. To determine the potential role of DMSP in black band disease (BBD), four BBD metagenomes were generated and analyzed for genes associated with DMSP metabolism, revealing more than 2000 sequences associated with the major degradation pathways demethylation and bacterial cleavage. The number of sequences associated with the bacterial cleavage genes dddD and dddL was ~1.5 fold greater than that of the demethylase gene dmdA, suggesting that bacterial cleavage and its products 3-hydroxypropionate (3HP) and acrylate may be more functionally significant than demethylation. However, two metagenomes had a greater number of dmdA related sequences when compared to dddD and dddL, suggesting variation across BBD communities. The number of dddD related sequences was consistently higher than dddL, indicating that 3HP may be more important in community metabolism than acrylate as it is further metabolized to produce acetate, a commonly utilized energy source by many heterotrophic bacteria. This could contribute to BB-disease persistence. The presence of genes related to both pathways suggests that co-metabolism of DMSP is occurring in BBD, possibly influencing microbial community structure. Thus DMSP production by the coral host may be an important factor in initiation and maintenance of the BBD community.

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SETTLEMENT PATTERNS AND PREFERENCES OF ALGAL-ASSOCIATED FISH RECRUITS (Abstract ID: 28390 | Poster ID: 203)

Coral reefs are in global decline, with live coral cover decreasing and macroalgal cover increasing in many regions. How these changes in benthic communities may affect the replenishment of key fish groups is not known. Naïve Siganid and Pomacentrid larvae were placed in a large circular aquarium and exposed to four different treatments. In the first treatment, the larva could choose to settle among live coral, dead coral, coral rubble and macroalgae. If macroalgae was preferred, the larva could choose between different macroalgae species, followed by increasing height and density of Sargassum. Siganus canaliculatus and S. spinus preferred to settle in macroalgae and Sargassum thalli of greater density more frequently than other habitats, however, increased height of Sargassum thalli did not significantly influence settlement preferences. In contrast, Pomacentrus adelus and P. wardi did not show any settlement preferences for different benthic substrates or macroalgae species. However, P. adelus and P. wardi are often observed hiding under rocks in macroalgal beds (pers. observation) and when given a choice in an aquarium, rocks of greater surface area was preferred more frequently than smaller-sized rocks. Consequently, the availability of dense Sargassum and hard substratum structures promote settlement of siganids and pomacentrids respectively. This study highlights the importance of macroalgae species and habitat features in influencing settlement preferences and distributions of algal-associated fish larvae.

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RESTRICTED GROUPER REPRODUCTIVE MIGRATIONS SUPPORT COMMUNITY-BASED MANAGEMENT (Abstract ID: 28025)

Conservation commonly requires trade-offs between social and ecological goals. For tropical small-scale fisheries, spatial scales of socially appropriate management are generally small - the median no-take Locally Managed Marine Area (LMMA) area throughout the Pacific is less than 1 $km^2$. This is of particular concern for large coral reef fishes, such as many species of grouper, which migrate to aggregations to spawn. Current data suggest that the catchment areas (i.e. total area from which individuals are drawn) of such aggregations are at spatial scales that preclude effective community-based management with no-take LMMAs. We used acoustic telemetry and tag-returns to examine reproductive migrations and catchment areas of the grouper *Epinephelus fuscoguttatus*, at a spawning aggregation in Papua New Guinea. Protection of the resultant catchment area of approximately 16 $km^2$using a no-take LMMA is socially untenable here, and throughout much of the Pacific region. However, we found that spawning migrations were skewed towards shorter distances. Consequently, expanding the current 0.2 $km^2$ no-take LMMA to 1-2 $km^2$ would protect approximately 30-50% of the spawning population throughout the non-spawning season. Contrasting with current knowledge, our results demonstrate that species with moderate reproductive migrations can be managed at scales congruous with spatially-restricted management tools.
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EXCEPTIONAL THREATENED CORAL POPULATIONS IN A MARGINAL REEF ENVIRONMENT ON THE SOUTHEAST FLORIDA REEF TRACT (Abstract ID: 29982 | Poster ID: 318)

The southeast Florida Reef Tract (se FRT) spans approximately 170 km of southeast Florida coastline from Miami (25.5°) to St. Lucie River (27.25°) consisting of a diverse coral reef community. Over 5.5 million people reside within 35 km of the reefs with a large portion being on the coast. Consequently the reefs have been impacted by a variety of anthropogenic stressors including altered hydrology, land-based sources of pollution, coastal construction, ship groundings and anchoring, and treated sewage effluent. Many previous studies have documented the regional decline of corals along the se FRT and

NOAA has listed seven coral species as threatened under the Endangered Species Act. Recent regional mapping has uncovered some previously-unknown, exceptional corals residing on nearshore hard-bottom habitats shallower than 10 m close to anthropogenic threats. Thirty-five locations of dense Acropora cervicornis were found exceeding over 156,000 m², only seven of which were previously reported, thus tripling the amount of known area. This is the largest amount reported in the continental United States. Additionally, 115 live stony corals greater than 2 m were identified (8 larger than 4 m), only a few of which were previously known. The majority of corals were Orbicella sp. (80%). Corals were found between 4.6 m and 8.8 m ($\bar{x}$ = 6.4 m) depth predominantly in the nearshore hard-bottom habitats. Most were spatially clustered into discrete areas along the coast. Assessments are underway and condition data will be presented for both populations.

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COMBINED EFFECTS OF PCO2 AND IRRADIANCE ON THE ENERGY RESERVES AND CALCIFICATION OF A REEF BUILDING CORAL (Abstract ID: 29018)

Ocean acidification (OA) from increased concentrations of pCO2 in seawater is predicted to reduce calcification rates in reef corals, and may affect the storage and metabolism of physiologically important energy reserves (lipids, carbohydrates, proteins). Irradiance levels affect the bioenergetics of reef corals, and the effects of OA are modulated by light availability. However, the interactive effects of OA and irradiance on coral biomass energy reserves are not well understood. This study used fragments of the reef coral *Pocillopora damicornis* from Kane'ohe Bay, Hawai'i, to test for light (400 vs. 800 umol photons m-2 s-1) and pCO2 (435 vs. 961 uatm) effects on calcification, symbiont and chlorophyll densities, and the composition (lipids, carbohydrates, protein) and energy content (kJ) of coral biomass. Fragments (N = 168) from seven adult coral colonies were exposed to treatments in 24 flow-through aquaria (n = 6 replicate tanks/treatment) for 32 d. Results revealed no effect of pCO2 or irradiance on net calcification or symbiont density. Carbohydrates/gdw increased under high light, but high pCO2 reduced lipids/gdw and biomass energy (kJ/gdw) and protein/cm2 was reduced under high light and high pCO2. These findings suggest OA will interact with irradiance to affect the composition and energetic content of coral biomass in this ecotype of *P. damicornis*. However, under ecologically relevant irradiances *P. damicornis* may be resistant to the OA-driven reduction in calcification reported for other reef corals.

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MARINE CONSERVATION FINANCE: IMPROVING THE AMOUNT, EFFICACY, AND EFFICIENCY OF INVESTMENT INTO CORAL REEF MANAGEMENT (Abstract ID: 28947)

The global conservation funding gap is estimated at $7 trillion USD and growing. For management of marine environments, funding is inadequate in terms of the size, duration, and diversity of revenue. Through critical policy analysis and semi-structured interviews, at the global scale and with Great Barrier Reef case studies, this research crosses disciplines and sectors to set the foundation of the "new and emerging field" of marine conservation finance. Case studies include 1) effective marine offsets for the Great Barrier Reef World Heritage Area, 2) a Great Barrier Reef sustainable agricultural loan fund that achieves water quality outcomes and private profits, and 3) a global assessment of opportunities and challenges to develop marine impact investments – models that generate net positive marine outcomes alongside financial returns. Results indicate that innovative finance mechanisms can be employed for marine conservation, but specialized capacity and transition capital need to be developed. Strategic consideration of finance – at the beginning of a conservation planning process and with the engagement of stakeholders – is a critical catalyst to achieving marine conservation outcomes. http://www.marineconservationfinance.com

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THE EFFECTIVENESS OF AN MPA NETWORK IN MANAGING THE WEST HAWAI'I AQUARIUM FISHERY (Abstract ID: 28241 | Poster ID: 267)

The commercial collecting of marine organisms for the aquarium trade has been a controversial activity in West Hawai'i for over 30 years. In January 2000, a network of nine Fish Replenishment Areas (FRAs) was established in West Hawai'i to address declines of aquarium-collected reef fishes and associated user conflict. The FRAs, which prohibit aquarium collecting, were designated with substantial community input and together with already established protected areas, comprise 35.2% of the coastline. Further management actions have followed over the succeeding years culminating most recently in new rules limiting aquarium collecting to only 40 permitted fish species, size/bag limits on three heavily targeted species and the addition of a new FRA in South Kona. Coupled with an extensive ongoing monitoring program, the West Hawai'i aquarium fishery is one of the most intensively managed and studied fisheries in Hawai'i. Nonetheless, in recent years distortion and misinformation, oftentimes deliberate and purposeful, have increased regarding the fishery and its impacts on West Hawai' reef fish populations. Drawing on coral reef monitoring data and other relevant scientific information, this talk will attempt to address some of the mythology surrounding the aquarium fishery and provide a more reality-based view of aquarium collecting and the effectiveness of the FRA network.

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NITROGEN ISOTOPES IN CORAL SKELETON-BOUND ORGANIC MATTER: INFLUENCES IN THE MODERN OCEAN AND APPLICATION TO FOSSIL TAHITI CORALS FROM THE LAST DEGLACIATION (Abstract ID: 28864)

The isotopic composition of skeleton-bound organic nitrogen in shallow-water scleractinian corals (hereafter, CS-d15N) is an emerging tool for studying the reef nitrogen cycle in the past. We have developed a sensitive and precise method for measuring CS-d15N at seasonal resolution (Wang et al., 2015). Many coral reefs receive their primary nitrogen sources from the open ocean, and the CS-d15N of these corals may provide information on past changes of the open ocean regional and global nitrogen cycle. In this study, we measured CS-d15N in modern shallow-water scleractinian corals from 8 sites proximal to the open ocean. A broad range in CS-d15N (of ~10‰) is measured across these sites, with a strong correlation between CS-d15N and the d15N of the deep nitrate supply to the surface waters near the reefs. While CS-d15N can be affected by other N sources as well and can vary in response to local reef conditions as well as coral/symbiont changes, this survey indicates that, when considering corals proximal to the open ocean, the d15N of the deep nitrate supply to surface waters drives most of the CS-d15N variation across the global ocean. Thus, CS-d15N is a promising proxy for reconstructing the open ocean nitrogen cycle in the past. With this new tool, we have measured CS-d15N in fossil Tahiti corals (with U-Th ages of 14.3 ka, 13.3 ka, 11.8 ka and 8.4 ka) collected during the Expedition 310 of International Ocean Discovery Program. The implications of these results for the regional nitrogen cycle as well as the deglacial changes in Southern Ocean processes will be discussed.

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HOW CORALS GOT BONES -- COMPARATIVE GENOMICS HIGHLIGHTS THE EVOLUTION OF CORAL CALCIFICATON (Abstract ID: 28763 | Poster ID: 23)

The massive calcium carbonate skeletons of reef-building corals form the large structures that provide an essential habitat for a variety of marine species. Here, we set out to understand how the non-calcifying ancestor of contemporary corals evolved to become a foundation species of an entire ecosystem and to identify genes essential for the calcification process. For this purpose, we assembled and annotated the genomes of the two Corallimorpharia Amplexidiscus fenestrafer and Discosoma sp., and compared them to the genomes of the non-calcifying anemones Nematostella vectensis and Aiptasia pallida, as well as the calcifying corals Stylophora pistillata and Acropora digitifera. Phylogenetic analysis using 1021 single copy genes confirmed that Corallimorpharia is a sister group of Scleractinia, thereby rejecting the "naked coral" hypothesis and allowing the use of this order as closest non-calcifying relatives of reef building corals in subsequent analyses. Ortholog analyses across the six genomes highlighted the expansion of several gene families involved in calcium ion binding, CARD domain binding, carbonate dehydratase activity and transmembrane receptor protein tyrosine phosphatase activity in Scleractinia. Phylogenetic tracing of calcification genes across the six genomes highlighted different evolutionary origins of these genes, including recruitment and adaptation of existing orthologs as well as gene duplications and neofunctionalization in the coral lineage.

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CORAL OPTICS AND THE USE OF PULSE AMPLITUDE MODULATED (PAM) FLUOROMETRY (Abstract ID: 29320)

Pulse amplitude modulated (PAM) fluorometry is widely used in photobiological studies of corals. PAM is easy to use and provides numerous photosynthetic parameters to assess coral ecophysiology. Essentially, PAM instruments measure chlorophyll a fluorescence that originates from Symbiodinium harboured within the host tissue. Recent studies of coral optics have revealed that both coral tissue and skeleton strongly scatter light and that such light scattering differs between coral species. Light scattering by coral tissues can affect the irradiance that Symbiodinium receives within tissues and might thus also affect the intensity of fluorescence detected by the PAM. In the present talk, we provide a brief overview on the optical properties of corals and then ask whether coral optics can affect the interpretation of PAM-based photosynthetic parameters. Specifically, we developed Symbiodinium-containing optical phantoms that imitated the optical properties of different corals in order to investigate if variable chlorophyll a fluorescence is affected by light scattering phenomena in coral tissues. Our main findings suggest that PAM-based photosynthetic parameters differ between artificial tissues with different degrees of light scattering but identical Symbiodinium density. These first results have important implications for the use of PAM in studies on coral health, stress and photosynthesis.
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CHANGES TO THE EARLY LIFE OF THE SEAHARE APLYSIA DACTYLOMELA WITH OCEAN ACIDIFICATION AND RISING TEMPERATURE. (Abstract ID: 29348)

Changes in the pH of the ocean that are predicted to occur this century due to climate change may have severe consequences for marine organisms by reducing calcification rates, growth and the ability to deal with other environmental stressors. The sea hare Aplysia dactomela is hermaphroditic and produces egg masses throughout the year on the southern Great Barrier Reef that contain thousands of embryos. In a series of experiments, newly produced sea hare egg masses were exposed to seawater with pH ranging from preindustrial to 7.6 in a flow through aquarium system treated with bubbled CO2. In the preindustrial treatment, CO2 was removed from seawater to increase the pH. Following treatments, the newly hatched larvae were also exposed to the pH treatments. In egg masses exposed to pH of 7.6, there were thinner walls, smaller egg cases with and fewer embryos per case and reduced growth of embryos. Hatched larvae demonstrated slower swimming speeds in the pH 7.6 treatment and higher mortality. In a separate series of experiments, egg masses were exposed to elevated temperature treatments and to combined pH and temperature treatments. Elevating the temperature 3°C had no obvious effect on embryo development. Combined treatments resulted in complete mortality of embryos just prior to hatching. This is the first study using Aplysia to evaluate changes in ocean acidification on embryo development of marine invertebrates.

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YOU'VE COLLECTED MESSY CROWD-SOURCED DATA – NOW WHAT? LESSONS LEARNED FROM A CONTINUOUSLY EVOLVING, DECADE-LONG MARINE CITIZEN SCIENCE PROJECT. (Abstract ID: 29580 | Poster ID: 732)

Marine ecosystems are undergoing massive transformation due to the effects of multiple human stressors. Action to protect what is left has been slow for many reasons, such as inadequate administrative capacities or stakeholder pushback, but a lack of data often supports inaction. Recent technological advancements and interdisciplinary collaborations have increased what is known. But the ocean is vast, and there are many data gaps. Projects that crowd-source data are increasingly being used to study marine ecosystems, and have the potential to fill some of these gaps. For example, eShark-Thailand (eOceans.org) has >13,000 records (>10,000 hours) submitted by divers on 185 sites, including encounters with sharks, rays, jellyfish, turtles, seahorses, etc. The problem, however, is that these data are messy: sites are not randomly assigned, effort is not standardized, contributors have varying experience, and species identification is not trivial. But, do these issues negate their value? Here, we present insights from a decade of lessons learned, and assert that crowd-sourced data can be valuable, if: the survey and database are compact and statistically robust with validation in mind; strong two-way relationships are made with outreach and field teams; and there is feedback from participants when interpreting results. We further demonstrate the value of these data through a marine spatial planning exercise using eShark-Thailand, where we investigate the hotspots and drivers of elasmobranch diversity and abundance, and overlay threats to delineate priority conservation areas.

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OCEAN ACIDIFICATION AND ITS IMPACT ON ECOSYSTEM PRODUCTION IN LAGOON AND OFFSHORE WATERS OF PALAU (Abstract ID: 29429)

Ocean acidification (OA) in offshore and lagoon waters of Palau have been studied from periodical and intermittent samplings in the past two decades (1992-2015). The decreasing trend was found for pH and Omega aragonite both in the offshore and lagoon waters, although the lagoon water was systematically lower by ca. 0.05 in pH and ca. 0.3 in Omega compared to the offshore water. Reef scale productivity was estimated from changes in the total alkalinity and dissolved inorganic carbon differences between the offshore and lagoon waters and compared with the past data. The reef scale calcification seems to be slightly recovering compared to the level found between years 1999 to 2002. The recovering trend of reef scale productivity may be due to the recovery of coral coverage in the reef slope and patch reef communities. From an incubation experiment using Porites cylindrica sampled in the lagoon, we found the calcification rate shows logarithmic response to Omega, and is more severely affected when omega reaches 2.0 which is expected to occur in mid-22nd century in Palau if this OA trend continues.

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GROWTH HISTORY RECORDED IN SKELETAL STABLE ISOTOPES IN THE MESOPHOTIC PORITES CORAL FROM THE GULF OF EILAT, RED SEA (Abstract ID: 28673 | Poster ID: 338)

Mesophotic coral ecosystems are found at depth below 30m. Due to its depth, the mesophotic zone is relatively protected from climatic and anthropogenic disturbance at the surface. Under relatively undisturbed conditions, mesophotic coral ecosystems may act as refugia. Owing to its depth, it has been difficult to observe mesophotic coral growth patterns and histories. Here we introduce geochemical approaches recording ocean environment for Porites coral growing from the mesophotic zone. Oxygen isotope provides sea temperature (ST) and salinity variability with distinct seasonal cycles. We used oxygen isotopes in coral carbonate skeleton to discuss coral growth histories in mesophotic zone. Two Porites corals were collected at sea surface and 50m depth from the Gulf of Eilat, the northernmost part of Red Sea. We applied skeletal oxygen and carbon isotopic analysis using stable mass spectrometry. Analytical results were compared with in-situ environmental data to discuss about difference of growth responses. These existed the difference of histograms of oxygen isotope record between predicted from ST and coral skeletons. The histogram of the mesophotic coral oxygen isotope records showed higher frequency of those recorded in summer than winter. This suggested a decrease or cessation of coral growth at mesophotic zone in winter. Usually, sea surface corals cease coral extension below 18°C at high latitude. Comparison of coral growth history between sea surface and mesophotic zone revealed that the temperature threshold of coral growth varied in response to coral water depth.

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A 100 YEARS CORAL GROWTH HISTORY IN VOLCANICALLY ACIDIFIED ENVIRONMENTS: ANALOGUES FOR CORAL ACCLIMATION TO FUTURE OCEAN ACIDIFICATION (Abstract ID: 29064)

Experimental and modelling studies are suggesting that the projected ocean acidification due to rising atmospheric carbon dioxide concentrations would have dramatically influenced on the calcification processes of marine organisms. Recent field based observation in volcanically acidified coral reefs have revealed on-going drastic ecological shifts. However, the long-term observation is very limited for the prediction of coral acclimation in future acidified ocean predicted in next century. Tropical shallow water corals could record long-term growth histories in annual bands of their aragonite skeletons as well as marine environmental changes during a few hundreds years. We discovered the large massive Porites corals living around active volcanic island of Satsuma Io-Jima, Japan, providing a unique opportunity to observe marine organism living under extreme

environments of low pH condition accompanied with volcanic gases emission from sea flower. We collected coral cores around the island inside and outside the rim ridges of Kikai caldera. We applied geochemical approaches (δ18O, δ13C, Sr/Ca, Mg/Ca, Ba/Ca, and F/Ca) and x-ray densitometry (calcification rate, skeletal density, and extension rate) to demonstrate the relationship between volcanic and hydrothermal activities and coral growth characteristics during last one hundred years, including submarine volcanic eruption in 1934. Coral extension rate at the site near hydrothermal vent was significantly small, suggesting the influence by low pH water and/or hydrothermal activity. We discuss the possible future analogue of coral acclimation against ocean acidification and marine pollution in natural system.

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WATER QUALITY IMPROVEMENT PLANNING AND INVESTMENT PRIORITISATION: A CASE STUDY FROM THE GREAT BARRIER REEF, AUSTRALIA (Abstract ID: 28918)

The Great Barrier Reef (GBR) Australia, is a unique ecosystem from ecological, social and cultural perspectives, and its interdependence with adjacent catchments. The health of the GBR is dependent on the function of the catchment and coastal ecosystems, and the quality of the water that is discharged from rivers and streams, mostly in wet season rainfall events. The adjacent catchment has been significantly modified since European settlement (~1850) through agricultural land uses, and to a lesser extent, coastal development. These changes have resulted in the transport of much greater loads of sediments, nutrients and pesticides to coastal and marine environments. The coastal ecosystems have also been heavily modified or removed, resulting in degraded habitats and disrupted hydrological connectivity. The challenge for natural resource managers is to adopt a whole-of-system approach to management, connecting knowledge of biophysical and socio-economic aspects of the catchments to the coastal and marine ecosystems. We present a case study in the Wet Tropics region in North Queensland of how this understanding has been incorporated into regional water quality planning. We outline the baseline data used for planning at regional scales, summarise the approaches to integrating indicators from the catchment to the reef, and identify priority actions and challenges. The water quality planning outcomes are being used to inform investment in the region, targeted to address declining water quality, possible drivers of crown of thorns starfish outbreaks and GBR ecosystem health.

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OCEAN ACIDIFICATION ALTERS MARINE INVERTEBRATE BEHAVIOUR VIA NEURAL IMPAIRMENT (Abstract ID: 29038)

Ocean acidification poses a range of threats to marine invertebrates including reduced growth and calcification. However, the potential effects of rising CO2 on marine invertebrate behaviour are largely unknown. Here we show that projected near-future seawater CO2 levels (~600, ~950 µatm) alter marine invertebrate behaviours. In squid, elevated-CO2 increased activity ~3-fold and altered their behavioural strategies when startled, with more squid choosing escape and inking at elevated-CO2, compared with threat responses at control-CO2. In gastropods, elevated-CO2 impaired escape behaviours during predator-prey interactions. Coral reef conch snails normally leap backwards rapidly when faced with a predator. However, elevated-CO2 halved the number of snails that jumped from the predator, increased their latency to jump and altered their escape trajectory. Elevated-CO2 impaired decision making but did not affect physical escape ability. Antipredator behaviour was fully restored by treatment with gabazine, a GABA receptor antagonist of some invertebrate nervous systems, indicating potential interference of neurotransmitter receptor function by elevated-CO2 in invertebrates, as previously observed in marine fishes. Altered invertebrate and fish behaviour at projected mid- to end-of-century CO2 levels could disrupt species interactions, community structure and food web stability with potentially far-reaching implications for marine ecosystems.
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NEMATODES DISTRIBUTION AND COMMUNITY STRUCTURE IN RHIZOPHORA MUCRONATA FOREST, MIDA CREEK- KENYA (Abstract ID: 29416 | Poster ID: 660)

Nematodes are among the most abundant organisms in marine ecosystems where they play a critical role in nutrient cycling, provision of nourishment to the higher organisms in the food web, pests control as well as acting as disease-causing vectors. Despite their importance and significance in marine ecosystem, there is inadequate scientific understanding of the nematodes' status and distribution in most tropical ecosystems. This study determined the distribution and community structure of nematodes in Rhizophora mucronota forest stand at Kirepwe and Dabaso sites of Mida Creek. Three replicates of sediments samples were randomly collected from one site Kirepwe and two sites in Dabaso (Dabaso site 1 and Dabaso site 2) using plastic corers (length= 10cm, diameter= 20mm). The samples were preserved using 5% buffered formalin solution, stained with Rose Bengal (to aid in sorting of the nematodes) and observed under a light microscope. Eighty one (81) genera of nematodes were encountered in the study mostly dominated by Terschellingia (15.3%), Molgolaimus (6.9%) and Paracomesoma (6.6%). Shannon Weiner diversity index were relatively high in the three study sites i.e. 3.31, 3.43 and 3.26 for Kirepwe, Dabaso site 1 and Dabaso site 2, respectively. Nematodes taxa evenness was similarly high in the three sites i.e. 0.50, 0.57 and 0.53 for Kirepwe, Dabaso site 1 and Dabaso site 2, respectively. The results further showed that the three sites had similar nematodes distribution and community structure ($p>0.05$, F-test) suggesting that diversity in mangrove sediments is regulated by mangrove tree species.
Key words: Mangroves, Taxa Diversity, Taxa evenness, Community Structure

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SEWAGE POLLUTION: MITIGATION IS KEY FOR CORAL REEF STEWARDSHIP (Abstract ID: 29004)

Coral reefs are in decline worldwide, and land-derived sources of pollution, including sewage, are a major force driving that deterioration. This review presents evidence that sewage discharge occurs in waters surrounding at least 104 of 112 reef geographies. Studies often refer to sewage as a single stressor. However, we show that it is more accurately characterized as a multiple stressor. Many of the individual agents found within sewage, specifically freshwater, inorganic nutrients, pathogens, endocrine disrupters, suspended solids, sediments, and heavy metals, can severely impair coral growth and/or reproduction. These components of sewage may interact with each other to create as yet poorly understood synergisms (e.g., nutrients facilitate pathogen growth), and escalate impacts of other, non-sewage based stressors. Surprisingly few published studies (8) have examined impacts of sewage in the field – but those that have, suggest negative effects on coral reefs. Because sewage discharge proximal to sensitive coral reefs is widespread across the tropics, it is imperative for coral reef-focused institutions to increase investment in threat abatement strategies for mitigating sewage pollution.

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WORKING WITH COMMUNICATION AND MESSAGING FOR VOLUNTEERS OLD, MIDDLE OLD, YOUNG AND YOUNGER (Abstract ID: 29868 | Poster ID: 709)

Communications in the digital age are far from straightforward. At the Hawaii Institute of Marine Biology, our Community Education Program volunteers and interns each have differing preferences on how they communicate and get their information. Sometimes these overlap and sometimes not, and at times our audience express strong feelings about some of the platforms (this can be negative or positive in direction). There are also limitations on each of the various communication methodologies. In addition to our volunteer docent program and our communication with teachers, we recently started a High School after school Marine Science Scholars club and noted that our traditional ways of communication were not working well. We show how we have partitioned our digital resources for our various audiences and resources, including a section in websites, blogs as repositories of training and teacher materials, videos to explain more complex behavior, bcc text messaging rather than email for routine communication with the younger generation, QR codes for recruitment brochures, cell phone calls when text will not do, and more.
http://coconutislandnews.blogspot.com/

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OPTIMIZATION OF DNA EXTRACTION FOR CHARACTERIZATION OF CORAL-ASSOCIATED MICROBIAL COMMUNITIES (Abstract ID: 28643 | Poster ID: 142)

Previous studies utilizing cultivation-independent methodologies have demonstrated that Bacteria and Archaea may play pivotal roles in coral health. Having robust meth-

odologies to describe the diversity and structure of these communities is imperative for answering questions about coral health status. However, extraction of microbial DNA from some species of coral can be challenging due to the presence of inhibitory chemical compounds. In an effort to identify a robust method for DNA extraction from Bacteria and Archaea specifically, rather than the coral tissue, a study was designed that examined the impact of six different DNA extraction treatments on seven common Caribbean and Pacific coral species. A two-part analysis was conducted: first, nucleic acid yield and PCR amplification efficiency of ribosomal DNA were evaluated after extraction. Second, PCR amplicons produced from DNA extraction treatments with the highest DNA yields and PCR efficiencies were sequenced using Illumina MiSeq and this data was used to examine the microbial community composition associated with each treatment. The results indicate that some DNA extraction treatments (PowerSoil® and PowerPlant ® Pro DNA Isolation Kits) were not suitable for effective extraction and subsequent PCR amplification of the microbial communities from the coral tissues. Other treatments (UltraClean ® Tissue & Cells and PowerBiofilm ® DNA Isolation Kits) resulted in better yields and amplification from *Orbicella faveolata* and *O. annularis* coral species. These results identify two DNA extraction methods that are best suited for the microbial community analysis of some coral species.

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## THE EVOLUTION OF THE GREAT BARRIER REEF OVER THE PAST 30 KA - NEW INSIGHTS FROM IODP EXPEDITION 325 (Abstract ID: 28511)

Sediments cored from the shelf edge of the Great Barrier Reef (GBR) during Integrated Ocean Drilling Program (IODP) Expedition 325 constrain the evolution of the GBR over the past 30 ka. This was a period of abrupt and major environmental perturbations, and responses of the GBR to these changes are largely unknown. We investigate the geomorphic, chronostratigraphic and biologic development of the GBR from 30 to 10 ka, using all available multibeam, seismic, C14 and U-Th dating, sedimentologic, and coralgal assemblage data. We define five distinct reef sequences over the past 30 ka, and discuss their chronostratigraphic development and paleoenvironmental settings. We document a highly dynamic system characterized by recurrent growth and demise of reef sequences as sea level fell to the Last Glacial Maximum (LGM) and then flooded across the shelf during the deglaciation. A major reef drowning event before the establishment of the modern GBR was likely caused by poor water quality associated with increased shelf flooding and sediment flux during the rise. As a system of reefs, the GBR has a remarkable capacity to migrate both seawards and landwards, despite major changes in sea level (e.g., meltwater pulses) and sea surface temperatures. This capacity - and the ability to re-seed itself locally - suggests the GBR was more resilient than previously described. Finally, we discuss the broader implications of the Exp. 325 record for understanding global reef demise and resilience, and for constraining relative sea-level changes.

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## MAPPING ANTHROPOGENIC AND ENVIRONMENTAL DRIVERS OF HAWAIIAN CORAL REEF ECOSYSTEM STATES (Abstract ID: 29770 | Poster ID: 406)

A major challenge for coral reef management is understanding how a wide range of interacting human and natural drivers cumulatively impact marine ecosystems; yet comprehensive, spatially explicit data on such drivers are often lacking. We quantified and mapped environmental and anthropogenic drivers of coral reef ecosystem states in the main Hawaiian Islands to fill this important data gap. Environmental drivers were derived from climatological ranges and anomalies of remotely sensed sea surface temperature, chlorophyll-a, irradiance and wave energy over long time series. We characterized anthropogenic drivers using empirically derived and modeled datasets to map fishing pressure, sedimentation, nutrients, new development, habitat modification, and invasive species. Some informative spatial patterns emerged, such as highly localized hot spots of land-based sources of pollution across the island chain. In addition, the greatest mapped values of habitat modification, invasive species and commercial and non-commercial boat-based fishing pressure were all on Oahu. The resulting data are available for download and exploration through several user-friendly online mapping services (e.g., SeaSketch, StoryMaps), facilitating their use by scientists and managers interested in how climate, human activity and ecology interact to drive reef diversity, resilience and ecosystem state. Ongoing projects are using these products to investigate relationships between driver intensity and ecosystem condition, which will ultimately support ocean planning and ecosystem management in Hawaiian waters.

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## ECOLOGICAL AND SOCIAL BENEFITS OF MARINE RESERVE NETWORK EXPANSION VIA DIFFUSION (Abstract ID: 28931)

Previous studies have shown that the "ad hoc" expansion of marine reserve networks is suboptimal to strategic expansion guided by systematic conservation planning. However, rather than being "ad hoc", the spread of community-based management can be explained by diffusion of innovation theory, which predicts for example that communities are more likely to adopt a conservation "innovation" (such as a marine reserve) if the benefits of doing so are directly observable or communicated by trusted peers. Using the example of marine reserves in the Philippines, we show that reserve system expansion following such a diffusion model may outperform representation-based conservation planning, both in terms of gaining stakeholder support and when assessed against objectives for population persistence. Reserves proximate to one another are more likely to exchange larvae via dispersal, creating synergistic effects that increase reserve efficacy. This is especially important where reserves are too small to support persistent populations within their boundaries, as in the Philippines. Though the existing reserve system is not fully representative of biodiversity features, growth following a diffusion model has resulted in sub-networks of connected reserves, which might help to explain the fisheries benefits observed within very small no-take marine reserves. In contrast, conservation planning that focuses solely on representation, without considering underlying ecological and social processes, could result in perverse outcomes for population persistence and fisheries-dependent livelihoods.

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## BIOGEOGRAPHY AND FUNCTIONAL ADAPTATION OF CORAL REEF MICROBES (Abstract ID: 29013)

The microbial communities inhabiting reef ecosystems influence the health and resilience of coral holobionts. Benthic primary producers contribute significantly to reef microbial ecology by manipulating key environmental parameters (i.e., DOM and oxygen availability, pH) that influence the abundance and composition of microbes. The community structure and metabolic potential was investigated for microbes inhabiting coral reefs across an extensive area in the central Pacific. We found that the microbial taxa present correlated strongly with the percent coverage of corals and algae, while the functional capacity of the communities correlated best with geographic location. Based on these findings, we predict that the carbon sources available to microbes primarily determine their community structure. To further investigate this prediction, the response of reef microbes to enrichment with dissolved exudates from three types of benthic primary producers was examined in two-day dark remineralization incubations. A subset of enrichment cultures were subjected to decreased pH in order to evaluate the compounded effect of DOM availability with acidification. Microbial growth rates,

DOC drawdown, and changes to taxonomic composition and functional capacity were measured. Together, these empirical and in situ studies provide greater insight into how microbial players adapt and respond to the shifts in benthic coverage that reefs are succumbing to worldwide.

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PALMYRA ATOLL RESEARCH STATION: UNDERSTANDING A NEAR PRISTINE MARINE ENVIRONMENT TO BETTER PROTECT MARINE ECOSYSTEMS GLOBALLY (Abstract ID: 30091)

In-depth assessments of intact marine ecosystems will provide valuable insights to the restoration and management of marine systems globally. Palmyra Atoll National Wildlife Refuge provides a premier location for research into some of the world's most pressing ecological concerns, including coral bleaching and disease, overfishing and other local anthropogenic stressors, invasive species, and climate change. Palmyra is co-owned and co-managed by the U.S. Fish and Wildlife Service (USFWS) and The Nature Conservancy (TNC), and TNC maintains a world-class research facility supporting a collaborative partnership with the Palmyra Atoll Research Consortium (PARC). PARC scientists have published more than 120 peer-reviewed papers over the past 10 years from their work at Palmyra. This presentation will outline Palmyra research and large-scale conservation projects that are informing global conservation management, such as the eradication of introduced rats that has had positive cross-system impacts, and the removal of three reef-polluting shipwrecks. Research at Palmyra continues with holistic food-web modeling, and monitoring of the behavioral ecology of top predators in pelagic, benthic, and terrestrial habitats of the Refuge. We will also highlight opportunities for additional cooperative research projects that can inform marine conservation and resource management for other tropical reef systems throughout the world's oceans.

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COLLABORATION BETWEEN RESOURCE AGENCIES AND DOD FURTHERS UNDERWATER INVESTIGATION AND CLEANUP AT FORMER DEFENSE SITES IN VIEQUES AND CULEBRA, PR (Abstract ID: 29395 | Poster ID: 689)

The former Vieques Naval Installation was used for military training from the 1940s until 2003. It is estimated that up to 9,000 acres may contain munitions and munitions-related items. The island of Culebra and adjacent cays were also used by the Department of Defense as an impact range from 1903 until 1975. Approximately 2,660 acres of Culebra and surrounding islands and cays were used in training exercises by various defense agencies. There is an unquantified amount of unexploded ordnance in underwater locations around both islands due to the use of in-water target areas and overshoots of and skips from land-based targets. The investigation and cleanup of Vieques Island, under the jurisdiction of the U.S. Navy, and of Culebra, under the jurisdiction of the U.S. Army Corps of Engineers (USACE) are ongoing. NOAA participates on technical committees led by the Navy and USACE created facilitate the cleanup of underwater areas surrounding these islands. Collaboration allows public safety concerns to be addressed while ensuring the protection of NOAA's trust resources, particularly ESA-listed corals. The creation and required implementation of standard operating procedures (SOPs) for underwater survey and cleanup work is a measure that has proven highly successful in enabling underwater investigations and limited cleanup efforts to proceed while protecting corals and other marine resources. SOPs include avoidance and minimization of impacts to corals and seagrass from vessel operation, in-water survey equipment, intrusive investigations, and removal actions.

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SHARING OR COMPETING? ECOLOGICAL NICHES OF JUVENILE SHARKS WITHIN A MUTUAL SHARK NURSERY (Abstract ID: 29437)

According to niche theory, ecologically and morphologically similar species need to segregate in different niches in order to avoid competition and to successfully coexist within the same habitat. Segregation between sympatric species can be achieved by either spatial, temporal, or trophic niche partitioning. Coastal reef sharks often use lagoons as nursery areas for their young, where inter-specific competition may be particularly high due to large numbers of pups. Investigation of competition within shark nurseries at fine spatial scales are lacking, despite its importance for coastal nursery management. At St. Joseph Atoll, Seychelles, two sympatric juvenile shark species, the sicklefin lemon shark, Negaprion acutidens, and the blacktip reef shark, Carchahinus melanopterus, use shallow flats as a communal nursery. Both shark species are viviparous with no maternal care, therefore inexperienced and opportunistic behaviour is assumed to lead to niche overlaps and competition. We investigated spatial and temporal niche partitioning between the species by manual active tracking and GPS loggers. We also quantified dietary overlap using visual and molecular analysis of stomach contents (DNA barcoding), and analysis of stable isotopes (SIA) of red blood and plasma tissues. Preliminary results show various degrees of spatial and trophic segregation between the two species. If niche partition results through the avoidance of competition, or if it is shaped by species-specific food or habitat preferences, remains to be proven.

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A COMPLEX ECOSYSTEM MODEL TO EVALUATE ECOSYSTEM SERVICES OF ALTERNATIVE MANAGEMENT SCENARIOS (Abstract ID: 29567)

Ecosystem modelling is increasingly used to explore ecosystem-level effects of changing environmental conditions and management actions. For coral reefs, there has been a push in recent decades toward the use of ecosystem models to evaluate effects of fishing and the efficacy of marine protected areas. However, ecosystem models that integrate physical, biogeochemical, and ecological dynamics, including human interactions, remain underdeveloped. An ecosystem model that does integrate all of these dimensions is the Atlantis model. We developed an Atlantis model of the coral reef ecosystems of Guam Island in the Western Pacific. We applied it to evaluate tradeoffs both from a management standpoint and from a resource users' standpoint. Using a suite of management scenarios prioritized in consultation with local resource managers, we quantified the ecosystem services (e.g. fishery landings, ecological state) in terms of socio-ecological costs and benefits of alternative management scenarios. We then evaluated the same management scenarios, but using performance indicators of the participation in reef fishery (an important social and cultural activity) and in diving (an important economic activity). This approach shows the utility of ecosystem models in evaluating socio-ecological tradeoffs.

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PAST, PRESENT, AND FUTURE MESOPHOTIC REEF SHELF ACCRETION POTENTIAL: A CARBONATE BUDGET APPROACH (Abstract ID: 29268)

Heterogeneous geomorphology in mesophotic reefs promotes high biodiversity and refuges for commercially important fish. Yet little data are available to understand the geological history and structural sustainability of the underlying architectural framework supporting these deep systems. To address these concepts, the first mesophotic reef carbonate budget model was used in the U.S. Virgin Islands at four upper mesophotic reef habitats with different structural characteristics. Combining bioerosion and calcification measurements, coral cover and rugosity surveys, and sediment composition analyses showed that coral growth did not always dominate gross carbonate production but all mesophotic reef habitats had positive net carbonate production rates. Rates were within the range measured by other studies for shallow-water reefs throughout the Caribbean but were lower than those estimated from mesophotic sites nine years earlier, suggesting mesophotic reef structure is not completely spared from climate change processes degrading shallow-water reefs. Still, net positive rates imply these mesophotic reefs are able to maintain and build structural complexity. Reef accretion and sea-level models suggest that variable net carbonate production rates were not the main driver of complex, shelf-wide geomorphology. However, assuming relatively continuous accretion rates since the stabilization of present-day sea level, results indicate net carbonate production variability greatly contributed to the habitat-scale structural complexity differences that help maintain high biodiversity.

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HERITABLITY OF CO2 TOLERANCE IN A CORAL REEF FISH (Abstract ID: 27974)

Projected future CO2 levels cause behavioural impairment in reef fishes and populations will need to adapt to maintain their performance. To evolve through natural selection a trait must exhibit heritable phenotypic variation. We tested for individual variation in

behavioural tolerance to high CO2 in the spiny damselfish, Acanthochromis polyacanthus, and then used parent-offspring correlations to assess the heritability of this variation in both field and laboratory populations. Adult pairs of A. polyacanthus and their offspring were collected from around Lizard Island and their response to chemical alarm cue (CAC) was tested after four days exposure to high CO2. Parent-offspring correlations were then performed. In the laboratory, breeding pairs of A. polyacanthus were formed based on their relative behavioural tolerance to high CO2. Offspring from these breeding pairs were reared in control and high CO2 treatments for six weeks. Offspring response to CAC was measured at six-weeks and compared to their parents and siblings. Both field and laboratory populations exhibited a close correlation between offspring and their fathers for tolerance to acute-CO2 treatment, indicating strong heritability in behavioural tolerance to high CO2. However, heritable variation was absent in offspring that had been chronically exposed to high CO2. This study uniquely demonstrates heritability in behavioural tolerance to projected future CO2 levels in both laboratory and wild populations, but also the potential for heritability to diminish with chronic exposure to environmental stress.

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HOST ENERGETIC AND STABLE ISOTOPE DIFFERENCES ASSOCIATED WITH PARASITISM IN TWO CORAL REEF FISHES (Abstract ID: 29067 | Poster ID: 251)

Parasites dominate coral reef biodiversity, effect host condition and behavior and thus can influence population and ecosystem dynamics. Cymothoid isopods of the genus Anilocra are large, conspicuous parasites of coral reef fishes. French grunt (Haemulon flavolineatum) and brown chromis (Chromis multilineata) are common hosts of Anilocra spp. infection in the Caribbean. To assess effects of Anilocra spp. on energetics of these fishes, we examined relationships between infection and muscle tissue composition and calories, and gut content volume. We also tested effects of A. haemuli on host oxygen consumption. To assess potential ecological effects of infection, we conducted stable carbon and nitrogen isotope analyses of infected and uninfected fish. Infected grunt had reduced muscle condition but similar calorie values and gut volume compared to uninfected fish. Infected chromis had similar muscle condition and caloric values compared to uninfected fish. A. haemuli infection also significantly increased host oxygen consumption while swimming, and increased respiratory demand was not alleviated with parasite removal. French grunt δ13C values reflected seagrass isotope values, but infected fish were significantly enriched in 13C and 15N. Thus infected French grunt feed on different prey, and/or are in poorer condition, compared to uninfected fish. For brown chromis there was no significant effect of infection on 13C and 15N. Our study provides evidence of a host-specific link between parasite-driven physiological and ecological effects involving reef fishes.
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A COLLABORATIVE APPROACH ON MARINE PROTECTED AREA NETWORK ESTABLISHMENT IN INDONESIA, A CASE STUDY FROM NUSA PENIDA AND BANDA ISLANDS (Abstract ID: 28124)

The reformation regime in Indonesia raising an opportunity for stakeholders to be more involved on marine conservation effort. In the previous era, the top-down approach by government was dominant where stakeholders participation were excluded. Conflicts appears in protected areas included marine protected areas (MPAs) between community and government related management authority. The government declared new laws in term of coastal and marine resources management included fisheries and marine conservation. Its such as Law No.31, year 2004 regarding Fisheries, and Law No.27, year 2007 regarding coastal and small island resources management. The laws mentioning important of stakeholders participation into fisheries, coastal and marine resources management. In term of providing best practices in Indonesia, the Nusa Penida MPA in Bali and Banda Islands MPAs in Maluku, utilizing the opportunity to develop a collaborative approach on MPA and the network establishment. Its combination between bottom up and top down approach. Stakeholders has a chance to be actively involved on MPAs establishment and management proportionally. The lessons learned are combination between traditional knowledge and scientific datas are the best input on MPA and its network design, in certain stages the collaborative approach take time and need more resources as the result develop a strong support as well as minimilizing conflicts on MPA establishment processes.

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IS PRIVATIZATION THE NEW GREEN? TWO NON-GOVERNMENTAL ENFORCED MARINE RESERVES IN CHINA AND TAIWAN (Abstract ID: 28048 | Poster ID: 636)

Marine reserves (MRs) have emerged as a preferred method to protect coral reefs from overfishing and human disturbance. However, due to ineffective enforcement by governments, many MRs have been reduced to mere "paper parks". This is especially true in many Asian countries such as China and Taiwan where compliance is low and resources dedicated to enforcement may be scarce. Privately managed marine reserves (PMMRs) or locally-managed marine reserves (LMMRs) may be effective in areas where government enforcement is lacking. We aimed to determine if PMMRs and LMMRs are a viable alternative strategy to protecting coral reefs. In Taiwan and China, we surveyed and compared the fish and coral coverage in national marine reserves (MRs) to that in areas of coral reef leased to and managed by dive operators and beach-side lodges (PMMRs/LMMRs). Generally, we found higher fish abundance, species number and fish size at sites within PMMRs/LMMRs compared to MRs. However, in China, other human impacts such as marine debris and illegal coral collection in PMMRs were evident. The increasing popularity of social media and mobile phones with cameras has meant that many instances of illegal fishing or human disturbance have been broadcasted quickly. With the use of social media by aware citizens to aid compliance, PMMRs and LMMRs would be an alternative coral reef management strategy in these countries.

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UNRAVELING SOFT CORAL EARLY DEVELOPMENT AND ITS MOLECULAR BASES (Abstract ID: 28789)

The early development of the hard coral Acropora millepora has been described at both the morphological and molecular levels, and comparative studies are under way for other Scleractinia. Complementary data on Octocoral embryogenesis are essential for a broader understanding of the different developmental strategies in Cnidaria and their evolution. This pioneer study establishes the morphological and molecular bases of embryogenesis in a soft coral using Lobophytum pauciflorum. Early development in Lobophytum is morphologically unlike development in other studied Scleractinia. Stages between the fertilised egg and the 16-32 cell morula consist of an irregular cell mass without obvious blastomeres. After their appearance successive rounds of cell division follow, first creating smaller blastomeres and with decreasing cell size returning to an irregular mass of cells with a relatively smooth surface. Molecular data are crucial for a full understanding of this process in Lobophytum and its comparison to Anthozoa. Thereto, transcriptome sequencing was carried out on unfertilised eggs, a range of morphologically distinct developmental stages and adult individuals. Using Lobophytum gene predictions as reference, temporal patterns of differential expression were established relative to the adult stage. We further aim to identify the homologs of key Acropora developmental genes in Lobophytum: comparison of expression patterns using in-situ hybridisation should increase understanding of the molecular bases of the broad range of developmental strategies displayed by Anthozoa.

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CORALS & CLIMATE ADAPTATION PLANNING: APPLYING CLIMATE-SMART PRINCIPLES FOR RESILIENCE-BASED MANAGEMENT (Abstract ID: 28204)

The Corals & Climate Adaptation Planning (CCAP) Project is a collaborative effort to explore frameworks and methodologies for climate change adaptation planning for coral reefs. Operating under the auspices of the Climate Change Working Group of the U.S. Coral Reef Task Force, its goal is to tailor and explore the utility of a recently-developed Climate-Smart framework for use in resilience-based coral reef management. A first draft of the tailored CCAP framework was explored and critiqued at a stakeholder workshop in Honolulu, Hawaii in July, 2014. Using West Maui as a case study location, special focus was given to the thought process for brainstorming adaptation options and adjusting existing management activities through Climate-Smart design. Based on these workshop discussions, an Adaptation Design Tool has been developed that integrates information on vulnerability, resilience, and adaptation strategies gleaned from the literature and provides a stepwise process for designing place-specific, climate-smart adaptation options for resilience-based management. This presentation will provide an overview of the CCAP Project and associated Adaptation Design Tool, including results of expert consultations with practitioners in Hawaii and Puerto Rico to test the utility of the tool using real-world examples from their existing management plans.

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GROWTH, FEEDING PREFERENCES AND SURVIVORSHIP OF CAPTIVE BRED SEA URCHINS, TRIPNEUSTES GRATILLA, AND POSSIBLE USE AS BIOCONTROL FOR INVASIVE ALIEN ALGAE (Abstract ID: 29189)

Over the past 70 years, Kaneohe Bay has seen aggressive spread of alien invasive algae. Native algae and corals are being increasingly replaced with expanding monocultures of alien algae in large areas of the bay. Programs to remove macroalgae from the reef are supplemented with native hatchery-raised urchins being released onto cleared reefs to prevent regrowth. We investigated the survivorship, growth and dietary preferences of these hatchery-raised urchins, to evaluate their likely efficacy as biocontrol agents. When fed ad libitum on single species of algae, urchins grew significantly faster on diets of Graciliaria salicornia and Kappaphycus clade B than on Eucheuma denticulatum, with intermediate growth on Acanthophora spicifera. In choice feeding trials, we find small urchins (22.5 mm test diameter) preferred A. spicifera to all other species of algae. Medium-sized urchins (25 – 43.5 mm TD) fed preferentially on both A. spicifera and E. denticulatum. Large urchins (45mm TD) grazed all algae at high rates, with significant affinities for A. spicifera and K. clade B. Post-transport survivorship of outplanted urchins was measured in paired open and closed cages in three different reef environments (lagoon, reef flat and reef slope). Survivorship in closed cages was highest on the reef flat (75%), and intermediate in the lagoon and on the reef slope (50%). In contrast, open cages showed similar survivorship on the reef flat and in the lagoon, but only 20% of outplanted urchins survived in open cages placed on the reef slope, suggesting predation on the deeper reef slopes.

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TOWARDS AN INTEGRATED APPROACH TO CROWN-OF-THORNS STARFISH MANAGEMENT AND RESEARCH ON THE GREAT BARRIER REEF (Abstract ID: 28893 | Poster ID: 622)

Crown of thorns starfish (CoTS) have been a persistent focus of management on Indo-Pacific reefs for the last 50 years. To date the strategies for addressing CoTS have been simple– find locations with high densities and kill as many as possible. Such approaches have had limited success but, with the exception of new methods for killing, management approaches have evolved little. On the GBR, recognition that the urgency and scale of the problem vastly outweighs the resources available is driving a change – a shift to working smarter not just harder. Principles of Integrated Pest Management developed in terrestrial systems have led to the realization that existing CoTS biological and ecological knowledge must be integrated with an understanding of the spatial dynamics of CoTS populations. This integration is key to developing management strategies that increasingly will rely on models to predict population outcomes, their interaction with management, and to assess the effectiveness of alternative management options. Also significant is recognition that CoTS management is not a single problem with a single solution but rather a multi-scalar problem with different objectives and methods being relevant at different spatial scales, and at different times and places. In this presentation we review these developments and present an attempt to integrate across our current understanding of CoTS biology and ecology, and, our management capacity and objectives, to provide a coherent and ecologically-based framework for linking CoTS research and management on the GBR.

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NOTHING IN *SYMBIODINIUM* BIOLOGY MAKES SENSE EXCEPT IN THE LIGHT OF CORRECT SPECIES IDENTIFICATION (Abstract ID: 29684)

In light of modern genetic techniques, there is growing awareness that taxonomic designations of *Symbiodinium* do not reflect biological reality. When these hidden species boundaries go undetected they cause spurious conclusions about their biology. Here we begin by describing the extent of this problem. We then give a brief introduction to several analytical techniques that have provided solutions, all of which generally aim to assign individual genotypes to genetically recombining groups prior to further analyses. We then discuss the results of several recent studies that have employed this approach, highlighting how critical errors in interpretation were avoided by first resolving species boundaries. We show that these approaches are an important first step in connectivity studies and highlight the critical role they have played in justifying the taxonomic status of several new species of *Symbiodinium*. Finally, we conclude with an examination of how these observations in *Symbiodinium* might extend to the study of other poorly resolved taxonomic groups, many of which reside on coral reefs.

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QUANTIFICATION OF LAND BASED SOURCES OF POLLUTION IN SUPPORT OF CORAL REEF MANAGEMENT: CASE STUDIES FROM TWO U.S. CORAL REEF TASK FORCE PRIORITY WATERSHEDS (Abstract ID: 27984)

The U.S. Coral Reef Task Force has designated three priority watershed sites: Guánica Bay (Puerto Rico), Faga'alu Bay (American Samoa) and West Maui (Hawaii). The goal of these designations is to reduce land-based sources of pollution (LBSP) by facilitating and enhancing coordination, partnerships, and contributions of local and federal agency resources and expertise. By concentrating efforts in selected areas, the aim is to enact geographically specific integrated activities to reduce pollutant loads to coral reef ecosystems. Here, interdisciplinary scientific assessments in two of the priority watersheds (Guánica and Faga'alu) are presented, and the conclusions and management implications are compared. These studies, conducted by NOAA scientists alongside local and academic partners, quantified a variety of pollutant stressors, including sedimentation, nutrients and toxic contaminants, as well as metrics of coral reef ecosystem health. While both ecosystems are threatened by multiple pollution issues, the size and complexity of the Guánica watershed makes the task of managing these threats relatively more difficult than in Faga'alu. The demonstrated differences between these two systems reinforces that management actions to benefit coral systems cannot be "one size fits all" approach and must be tailored to an individual system.

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POTENTIAL SYNERGIES OF THE CORAL TRIANGLE MARINE PROTECTED AREA SYSTEM AND MARINE TOURISM (Abstract ID: 27997)

The Coral Triangle countries: Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste, each have evolving systems of marine protected areas (MPAs) at the national and local levels. Now with more than 1,900 MPAs covering 208,152 km2 (1.6% of the combined extended economic zones), the Coral Triangle Initiative for Coral Reefs, Fisheries and Food Security has endorsed a Regional Plan of Action that contains a target of establishing a "Coral Triangle Marine Protected Area System" (CTMPAS)as part of its goal on improving MPA management and expanding coverage to 20% of all critical marine habitats in the region. This presentation highlights the CTMPAS Framework and Action Plan and describes its development and contribution to improved resource management. The MPA System Framework contains guidance for standardizing how MPAs and MPA networks are evaluated for effectiveness, and provides options for scaling-up existing MPAs to networks of MPAs that are ecologically linked, integrated with fisheries management and responsive to climate. The Framework also provides for a link to private sector driven marine tourism as a means of supporting management and enhancing demand for conservation. Incorporation of marine tourism in the management framework provides incentives for the national and regional institutional players in government and the private sector to facilitate the continued sustainable development and implementation of the regional MPA system that focuses largely on improved management,expanded coverage at scale and human economic benefits.

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TRADEOFF ANALYSIS FOR BALANCING MULTIPLE OBJECTIVES IN OCEAN MANAGEMENT (Abstract ID: 29556)

Marine conservation and management is a complex multi-objective challenge. Expansion of uses and industries reliant on marine ecosystem services and resources (e.g., fisheries, shipping, energy, aquaculture, coastal development, recreation) is exacerbating inter-sectoral conflicts and threatening conservation and sustainable use objectives. Tradeoff analysis is a decision-making tool that is well-suited to address this problem, because it explicitly accounts for multiple objectives and is adaptive to the location, scope and complexity of the problem. However, its utility remains uncertain or unknown to many scientists and managers, and its applications to marine systems are few. Our aim here is to demystify tradeoff analysis, and operationalize it in the hands of scientists and managers seeking to balance multiple potentially conflicting objectives in ocean management. We outline the framework of tradeoff analysis, then trial the tool with three novel coral reef system case studies: dredging of post-Panamax cruise ship lanes in Bermuda in relation to coral destruction yet enhanced tourism, design of periodically-harvested closures in Melanesia for meeting fisheries and conservation goals, and cost-effective repair of roads in west Maui for reducing sediment flow to adjacent coral reefs. In all cases: the tradeoff analysis steps are simple and tractable, the results reveal solutions that best minimize conflicts and maximize multiple ecosystem services delivery, and the value of the tradeoff analysis over conventional management is substantial.

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THE EYES OF THE REEF NETWORK & BLEACHAPALOOZA 2015: HAWAII'S OCEAN COMMUNITY PROVIDES DATA ON EXTENT AND SEVERITY OF CORAL BLEACHING EVENT TO RESOURCE MANAGERS (Abstract ID: 30065)

Hawaii's reefs span an enormous geographical area making it difficult for resource managers to detect the early onset of coral bleaching, disease, Crown-of-Thorn seastars (COTS) and invasive species outbreaks. Reef users are essential in helping managers monitor reefs, providing the critical mass of 'eyes on our reefs' needed to detect and respond to events in an expedient manner. The goal of the Eyes on the Reef (EOR) Network is to inform, engage and train community members, ocean user groups, managers, NGOs and others in identification of coral bleaching, disease or COTS outbreaks and aquatic invasive species. The EOR Network is a broad outreach and education program that helps to provide the critical first tier of Hawaii's Rapid Response Contingency Plan and promote community stewardship of our valuable marine resources. In 2015, NOAA's Coral Reef Watch predictive satellite tools forecasted the most severe bleaching event in Hawaii's history. At the peak of the warm water event on October 3, a statewide effort known as 'Bleachapalooza' was organized to engage concerned ocean users to file reports of coral bleaching to capture the extent and severity of the bleaching event. Prior to the event, in the month of September when bleaching was highly visible, EOR received 66 reports. Bleachapalooza more than doubled that number with a total of 156 reports in October, giving managers a geographically broader and more detailed look at the event than was possible on their own. Citizen science is a critical component to management detection and response to threats to our reefs.
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EVALUATING METAPOPULATION PATCH VALUE IN A MULTISPECIES CONTEXT FOR MARINE RESERVE DESIGN (Abstract ID: 29701)

The idea that some patches within a metapopulation can act as sources is key to marine reserve design. Theory dictates that high-value sources should be protected from harvest in order to ensure persistence and higher biomass. However, the nebulous "source" concept actually encompasses a number of distinct and potentially unrelated dynamic processes. To gain clarity in how metapopulation theory can best be applied to reserve design, we evaluated the utility of a suite of 'patch value' metrics that have been proposed as measures of 'source-ness' in metapopulations: self-persistence, self-recruitment, net import, net export, centrality, and deletion value. We calculated each metric for each of six fish species in a metapopulation model that included information on habitat distribution (km2-scale) and ROMS-derived larval connectivity patterns. We then simulated the assembly of reserve networks using each of the metrics as a reserve-selection rule, and calculated the overall biomass and yield of the six species as a measure of reserve success. Overall, we found that networks selected based on deletion value, larval export, and centrality performed well, while self-persistence was not a good predictor of overall metapopulation performance (likely because there were few sites with sufficient larval retention to be self-persistent). Our results emphasize the value of reserve networks, rather than lone reserves, for fishery and conservation success, as well as the challenge of finding reserve configurations that succeed for multiple species with disparate dispersal patterns.

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DIVERGENCE IN A SINGLE TRAIT DRIVES INCIPIENT SYMPATRIC SPECIATION IN CORAL REEF FISH (Abstract ID: 30117)

There is growing recognition that ecological adaptation shaped by natural selection may be a major driver of diversification on coral reefs. In theory, speciation-with-gene flow is most plausible when ecologically important traits directly cause assortative mating, but few natural examples are known. Here, we demonstrate the potential for a single trait, color pattern, to drive incipient speciation in a sympatric population of the polymorphic hawkfish, Paracirrhites arcatus. First, we provide data demonstrating color morphs are exploiting alternative ecological niches, driven by disruptive natural selection favoring color patterns that are better camouflaged in contrasting microhabitats. Second, our experiments show that coloration is also important in choosing mates. The combination of ecological isolation and assortative mating is driving reproductive isolation among color morphs. Third, genome-wide sampling revealed divergent patterns of genetic variation across color morphs that correspond well to those expected in models of speciation-with-gene flow. Whereas the majority of the genome is homogenized by gene flow, there is significant divergence in a few functional genes that are likely under selection. Taken together, these results provide evidence that color pattern alone can drive incipient divergence in a single species, despite high gene flow and no geographic isolation. We argue that this may be a common and potentially significant driver of diversification on coral reefs.

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HAVE INVASIVE LIONFISH IMPACTED THE PULLEY RIDGE MESOPHOTIC CORAL ECOSYSTEM? (Abstract ID: 29671 | Poster ID: 323)

Mesophotic coral ecosystems are deep fore-reef, low-light adapted, communities often comprised of scleractinian corals, macroalgae and sponges. At a depth of 60-80m, Pulley Ridge represents the deepest coral reef on the US continental shelf extending over 100km along the western edge of the Florida Platform. We surveyed this unique ecosystem using AUVs, ROVs, and technical diving; the reefs consist of at least 25 species of algae (~50% cover), 18 species of scleractinian corals (<1% cover), and over 50 species of sponges (1-2% cover), in addition to more than 80 species of fish. The

percent cover data represent a significant loss of coral and sponges relative to surveys conducted about a decade earlier. The impacts of coral reef stressors (e.g., bleaching, disease, hurricane damage, and acidification) have not been observed on Pulley Ridge, but the invasive lionfish, Pterois volitans, was first reported on these MCEs in 2010. We observed densities as high as 6.8±3.7 lionfish m-2, typically within "grouper holes", as well as active foraging on many species of fish. While direct comparisons of the Pulley Ridge fish populations pre- and post-lionfish need to be interpreted cautiously, there does appear to be a marked decline in several taxa. We hypothesize that the loss of coral and sponge cover, to increases in algae cover, is an indirect effect of lionfish grazing on herbivorous fishes, which releases algae from herbivory to out-compete slower growing corals and sponges.

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SUSTAINABLE FINANCING FOR THE BIRD'S HEAD SEASCAPE AREA IN WEST PAPUA (Abstract ID: 29379)

The Bird's Head Seascape (BHS) region is the global epicenter of marine biodiversity where there are about 600 species of hard coral. The number of species is 75% of all hard coral species known to science today, so it is often referred to as the heart of the coral triangle, that is the triangular area of 6 countries that have the highest levels of coral diversity in the world. It is also known as kingdom of fish since more than 1,700 species of fish recorded by scientists. The BHS area is habitat for several endangered charismatic species as well. The wealth of the BHS's resources is a source of livelihood and food security for local residents. Therefore, to avoid the destruction of this area, initiatives to establish Marine Protected Areas in the Bird's Head Seascape has been done, as the result of a cooperation of the 'Bird's Head Consortium ' which is composed of government, local government and environmental NGOs such as CI, TNC, WWF, Starling Resources, and others. This collaboration have produced 12 Marine Protected Area with a total area of 3.6 million hectares spread out across several districts in West Papua and Papua. The main challenge in the management of Marine Protected Areas is 'high costs required' for the management. To answer this challenge, Yayasan Kemitraan Jantung Konservasi Dunia (YKJKD) or Partnership Foundation for the Global Epicentrum Conservation, has been established. YKJDK is designed to assist efforts to fill the shortage of funds management of this area through the establishment of 'trust fund' in the form of 'endowment' (endowment fund) or 'grants' (sinking fund) that locally managed for the longterm conservation purposes.

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THE STRONG EL NIÑO, SEA LEVEL DROPS, AND SMELLY REEFS OF 2015–2016 (Abstract ID: 28813)

With El Niño events, come above-normal sea levels in the eastern Pacific and sea level drops in the west. During past strong events, such as that of 1997–1998, when trade winds temporarily stopped and allowed warm surface waters to slosh eastward, sea levels in the tropical northwestern and later the south-central Pacific were more than 30 cm below normal for several months. Such sea level drops exposed shallow corals to air at low tide (which became smelly) for much longer periods than they are normally exposed to. This can contribute to the formation and maintenance of microatolls, but also leads to widespread coral bleaching and death, thereby damaging shallow-water coastal ecosystems. Here we discuss the sea level drops of 2015–2016, associated with the strongest El Niño of the 21st century (so far), and report on the coastal exposure that occurred around Guam in 2015 and is predicted for American Samoa in 2016.

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TRANSCRIPTOMIC BASIS OF HEAT STRESS TOLERANCE OF CORALS FROM THE WORLD'S HOTTEST SEA, THE PERSIAN/ARABIAN GULF (Abstract ID: 28723)

Coral communities from the Persian / Arabian Gulf ("The Gulf") survive summer temperatures of up to 35°C on a regular basis. Most corals elsewhere on the planet, including conspecifics of Gulf corals, are already killed at water temperatures above 32°C. Therefore, corals from the Gulf represent ideal models to study the limits of thermal tolerance in reef corals. Gene expression forms an integral part of the organismal response to challenging environmental conditions, the altered expression patterns can result from changes in both, the constitutional expression and the short-term regulation of stress-response genes. We have selected Porites lobata as a model to study gene expression of Gulf corals as this species 1) has a cosmopolitan distribution, 2) represents a habitat-forming species in the Gulf and 3) is suitable for long-term culture in experimental aquarium systems. Here, we present the results of our analysis of the transcriptome of Porites lobata from Sadiyaat reef and the changes in gene expression associated with the exposure to different environmental stressors.
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A MULTI-TRACER APPROACH FOR IDENTIFYING SEWAGE POLLUTION HOTSPOTS ON A HAWAIIAN CORAL REEF (Abstract ID: 29644)

Hawai'i's coral reefs are deteriorating as a result of multiple stressors, with sewage being one of the most devastating ones. Puakō, a coastal community on Hawai'i Island, is one location of particular concern. It has some of the state's richest coral reefs, but coral cover has decreased 50% in the last 40 years, which is assumed to be associated with the high density of cesspools. However, data linking sewage pollution and reef deterioration are lacking. Our study used dye tracer releases, measurements of sewage indicators (fecal indicator bacteria, nutrient concentrations, δ 15N in macroalgae), and mapping tools to identify sewage pollution hotspots in near-shore waters at Puakō. Wastewater from homes reached shoreline waters within 6 hours to 3 days. Shoreline nutrient concentrations were two times higher than those in upland groundwater. Additionally, fecal indicator bacteria levels were high and variable along the shoreline, and much of the δδ15N macroalgal values were within the sewage range. To visualize sewage pollution hot spots, sewage indicator data layers were combined and used with mapping tools. Our study documented that sewage pollution is entering Puakō's nearshore waters, and highlights the need for a multi-tracer approach and mapping tools to identify sewage pollution hot spots for appropriate management actions.

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DEEP SEA GAZING: MAKING SHIP-BASED RESEARCH ABOARD RV FALKOR RELEVANT AND ACCESSIBLE (Abstract ID: 29187)

Schmidt Ocean Institute (SOI) is a private, non-profit operating foundation established to advance the understanding of the world's oceans through technological advancement, intelligent observation and analysis, and open sharing of information. Scientists compete for the right to go to sea on our research vessel Falkor where they can take advantage of a wide range of modern scientific utilities, such as broadband Internet, high performance computing, robotic systems, live video streaming, and state of the art scientific instruments and labs. SOI is one of the only research programs that make their entire underwater vehicle dive series available online, creating a collection of video data that enables anyone to follow the deep sea research operations in real time. We encourage students and teachers to take advantage of our programs and materials in classrooms. Telepresence-enabled research is an important component of Falkor cruises, and SOI supported several projects focusing on coral reef research in 2015. In this presentation, we will discuss the methods we used to make oceanographic research accessible to the public, including an image tagging citizen science project conducted in partnership with the Australian Centre for Field Robotics. Intelligent utilization of several robotic platforms, high performance computing system, and broadband Internet enabled real-time robot tracking, image tagging, and an array of outreach activities that helped scientists on board to engage the public in interactive exploration of the ocean in its fascinating detail.
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WORKING WITH FISHERS TO EVALUATE THE EFFECTS OF EXPERIMENTAL REMOVAL OF INTRODUCED ROI (CEPHALOPHOLIS ARGUS) ON REEF FISH POPULATIONS IN WEST HAWAI'I (Abstract ID: 29930)

Prior research showing that the introduced peacock grouper, locally known as roi, (Cephalopholis argus) consumed ~ 8 million fish/year from the reefs of west Hawai`i has raised concerns from fishermen and has inspired grassroots removal efforts statewide. A lack of scientific evidence corroborating the effects of roi on native prey fishes has led to mistrust and even threats from fishers towards reef managers. To resolve this disagreement, we worked with local spearfishers to implement a Before-After-Control-Impact experiment designed to detect changes in native fish communities after removal of roi at Puakō, Hawai`i. In April 2011, researchers and local spearfishers reduced roi populations by >90% on a 1.2 ha patch reef and surveyed fish populations twice a year for four years. Our findings indicate a significant decrease in roi abundance but no effect on native fish populations. A slight increase in small prey fishes (<15cm) was observed initially, but did not translate into an increase in overall fish biomass. Information was shared early and often at fishing tournaments and community events to increase mutual understanding between the fishing and management community, and fishers were active participants in multiple research projects linked to invasive fish removal activities, illustrating the benefits of honest and frequent communication to improve management-driven research effectiveness.

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BIODIVERSITY OF CULTURABLE BACTERIAL COMMUNITY ASSOCIATED WITH THE DISEASED CORALS FROM NORTH JAVA SEA COASTAL WATERS INDONESIA (Abstract ID: 28917)

Coral reefs are experiencing a recent period of severe decline due to emerging coral diseases. However, little is known about how coral diseases are caused. Our objective were to investigate the general insights into the diversity of the bacterial community associated with diseased corals. To achieve these objectives, sampling was conducted at 2 different reefs condition along Java Sea namely Panjang Island,(heavily impacted agricultural areas)and Karimunjawa Archipelago (relatively pristine area). Coral disease rapid assessment were conducted in dry season of 2015. The prevalence of coral disease on the reef building corals was calculated as the mean percentage of coral colonies affected by disease per 50m2 transect quadrat. While culture collection of 34 bacteria associated with coral diseases was established by plating on Zobell's 2214E. Early assessment on prevalence study conducted at those site locations showed that the prevalence of coral disease was very high for all diseases observed on all reefs in the Panjang Island (74.37±5.29%, mean±SE) and Karimunjawa 27.86 ± 2.7 % SE (mean ± SE). The most common diseases found on each locations, White Plague and Brown Band, were selected for further studies. Polyphasic identification of bacteria associated with diseased coral White Plague showed that these isolates were closely related to two major groups of bacteria: Bacillaceae and Vibrioceae. While following partial sequencings WP strains of the 16S rDNA shown that Brown Band strains belonged to two major groups of bacteria: members of the Pseudomoneae and Bacillaceae.

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BLOGGING 201: I'VE GOT A BLOG. NOW WHAT? (Abstract ID: 29222)

Blogs can play a key role in interfacing with the public. They can be used to create communities, share research findings, gain participants in citizen science initiatives, and even help drum up financial support. Starting a blog is easier than ever, with step by step instructions offered by major blog hosting sites such as Wordpress, however, advice for what comes next is harder to find. It is especially difficult to locate reliable information about best practices for scientists seeking to use blogs as outreach tools. Christie Wilcox, lead editor of Science Blogging: The Essential Guide, shares the best tips from the book to help you take your blog to the next level.

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NUTRIENT SUPPLY TO THE GREAT BARRIER REEF (Abstract ID: 28984)

The nutrient supply driving pelagic and benthic productivity over the whole Great Barrier Reef and Lagoon system is quantified using a shelf scale 3D hydrodynamic, sediment and biogeochemical model. The (eReefs) model is based on the CSIRO Environmental Modelling Suite augmented with key tropical marine processes modules including coral and seagrass growth, carbon chemistry, Trichodesmium nitrogen fixation, phytoplankton pigment synthesis and a spectral optical model for accurate representation of the in-water light field. Nutrient forcing at the ocean boundary was derived from climatology, along the coast from 22 major river systems and atmospheric supply was included via rain. The model was validated against observations over a 4 year hind-cast simulation and reproduced the observed nutrient climatology, spatial gradients in ocean colour chlorophyll and in situ sensor and water quality observations. Results from the 3D model show the dynamic nature of episodic (< 1 week) subsurface upwelling events along the shelf edge that channel nutrient rich water through gaps in the reef to boosting local productivity. Results are consistent with sparse continuous nutrient observations from moorings and gliders and the model provides significant insight into the interpretation of these observations and the design of observing programs in complex reef topography. Budget analysis for subregions of the shelf quantify the primary nutrient sources in wet- and dry-seasons and identify the relative impact of coastal, ocean and atmospheric supply relevant to water quality management of the reef.
http://www.emg.cmar.csiro.au/www/en/emg/projects/eReefs

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THE ESSENTIAL ROLE OF PLANNING FOR HUMAN DIMENSIONS OF LARGE MARINE PROTECTED AREAS (Abstract ID: 29970)

A new era of large-scale marine conservation has begun. Since 2000, more than 14 Large-Scale Marine Protected Areas (LSMPAs) have been declared - each more than 250,000 $km^2$ in size and totaling more than 7.2 million $km^2$. Due to their sheer size, complex socio-political realities, and distinct local cultural perspectives and economic needs, successfully implementing and managing LSMPAs is challenging. Given the rapid and recent growth in designation of LSMPAs and the potential challenges associated with creation and ongoing management, it was both timely and important to convene a "think tank" of, amongst other constituents, scholars and practitioners, advocates and critics to explore the human dimensions (HD) of LSMPAs. This global meeting held February 8-10, 2016: 1) evaluated existing human dimensions knowledge related to LSMPAs, 2) developed practical recommendations and identify best management practices regarding human dimensions considerations in LSMPAs, 3) produced a shared human dimensions research agenda for LSMPAs, and 4) launched an ongoing collaborative relationship among human dimensions researchers and Big Ocean, a learning network of LSMPA managers. The overarching goal of this collaboration is to be proactive in identifying solutions to overcome human dimensions challenges in LSMPAs. It is likely that overarching themes such as equity and transparency will be tenets based on HD research findings and experience. This presentation will highlight the outcomes of this meeting and how it has begun to influence LMPA planning and implementation.

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INTRAGENOMIC VARIATION IN SYMBIODINIUM CORRELATES NEGATIVELY WITH PHOTOSYNTHETIC EFFICIENCY AND HOST PERFORMANCE (Abstract ID: 28849)

Reef-building corals are nutritionally dependent on the symbiotic alga Symbiodinium. The coral host may therefore select for high-performing clonal symbiont lineages, resulting in host-symbiont co-evolution. Yet somatic genetic variation between Symbiodinium clones may affect host performance, particularly under sub-optimal conditions. Applying quantitative PCR (qPCR) to Pocillopora damicornis colonies from Lord Howe Island (AUS), we estimated the relative abundance of Symbiodinium cells with homogeneous ITS2 sequence copies of type C100, and intragenomically variable (IGV) cells with at least two distinct ITS2 sequences including types C100 and C109. We then analysed the physical status and photosynthetic performance of each colony at both ambient and elevated temperature (25 and 29 °C) in a closed-system oxygen flux chamber. The proportion of IGV Symbiodinium was negatively correlated with net photosynthesis and photosynthetic efficiency, and under thermal stress, colonies dominated by IGV cells could only meet respiratory demands at high irradiance (> 250 μmol photons m-2 s-1). IGV Symbiodinium were also estimated to be 50% larger by volume, occurred at lower density, and had higher chlorophyll c2:a ratios than the homogeneous cells. While it is unclear whether their mixed rDNA arrays result from incomplete concerted evolution or recombination, the associated reduction in performance suggests a possible deleterious effect of IGV. It also demonstrates that the beneficial capacity of symbionts can vary within populations, with potential implications for host fitness.

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DO CONSERVATION-FOCUSED DIVE BRIEFINGS REDUCE DIVER DAMAGE TO CORALS? (Abstract ID: 29940)

Diving tourism is generally considered "eco-friendly", but many coral reefs are dived intensively and are in danger of decline. Guam receives over a million tourists annually, and its coral reefs support about 300,000 dives each year. Dive boats frequent the same sites repeatedly, where divers damage corals by kicking, grabbing, bumping, entangling gear, and stirring up sediment. When reefs are dived intensively, these small but repetitive injuries to corals accumulate, and can result in delayed healing and tissue loss associated with algal overgrowth, disease, and predation. The effects of careless and uninformed diving practices on reefs could be mitigated through diver education with a focus on coral conservation. In this study, we deliver dive briefings containing varying levels of coral conservation information to divers on Guam, then observe and compare divers' coral contact rates during their dives. We also compare divers' contact rates with predictive factors such as camera use, experience, gender, and nationality to predict which divers cause the most damage and would most likely benefit from conservation-focused briefings. Benthic surveys will be conducted at intensively dived sites and similar undived sites to compare coral health and community structure. The results of this study will be used to support efforts of local agencies to legislate "eco-friendly" diving practices. They will also be presented at a workshop for local dive operators, who will be encouraged to include conservation material in briefings to promote long-term sustainable dive tourism on Guam.

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PRODUCTIVITY-DRIVEN SHIFTS IN CORAL REEF BENTHIC COMMUNITIES: WHEN IS THERE TOO MUCH OF A GOOD THING? (Abstract ID: 28863)

Changes in primary productivity have pronounced effects on coral reefs. In some instances, evidence suggests a positive effect of increased pelagic productivity and associated particulate food availability on the cover of calcifying benthic organisms (e.g. hard corals, crustose coralline algae). In contrast, extreme levels of primary productivity can often lead to undesirable regime shifts where fleshy macroalgae dominate. Identifying the conditions under which increases in primary productivity switches from being beneficial to reef-calcifiers versus leading to their demise is a research priority. Using a series of unpopulated Pacific reefs and by combining high-resolution in situ oceanographic measurements, benthic community surveys, isotopic analyses, and statistical modeling, we explore the effects of changing levels of primary productivity on benthic community structure. We show increases in particulate food supply driven by local oceanographic processes, such as internal waves and downwelling, can correlate with higher heterotrophy in hard corals and their overall dominance as benthic competitors. The relationship between nutrients and coral dominance has a limit; at the extreme, these same oceanographic processes of nutrient delivery operating at similar intra-island spatial scales can elevate primary productivity to such a degree that corals lose the battle for space on the reef floor, resulting in stable regime shifts to fleshy macroalgae. Here we discuss at what point along the primary productivity axis these dramatic shifts in benthic organisation occur.

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IMPACTS OF 6 YEARS OF HERBIVORE PROTECTION AT KAHEKILI HERBIVORE FISHERIES MANAGEMENT AREA (KHFMA), MAUI (Abstract ID: 28384)

In response to concerns about declining coral cover and recurring macroalgal blooms, the State of Hawaii established the KHFMA in 2009. Within the KHFMA, herbivorous fishes and sea urchins are protected, but other fishing is allowed. We conducted surveys at KHFMA and comparison sites around Maui since 19 months before closure, and covering 6 years of herbivore protection. Over that period, mean parrotfish and surgeonfish biomass increased within the KHFMA, by 139% and 28% respectively. Most of those gains have been of small-to-medium species, whereas large-bodied species have not recovered, likely due to low-level poaching on what are preferred fishery targets in Hawaii. Nevertheless, coincident with rises in herbivore biomass, crustose coralline algal (CCA) cover has increased from ~2% before closure to ~ 15% in 2015. Biomass of unprotected families did not change in the KHFMA, and there were no similar changes in parrotfish or CCA at 12 comparison sites around Maui. In spite of positive signs, it is unclear how effective the KHFMA might eventually be for its ultimate goal of coral recovery. Coral cover declined from 39.6% to 32.9% between 2008 and 2012, with nearly all losses occurring prior to herbivore biomass increasing. Coral cover subsequently increased to 35.4% by early 2015. However, a severe bleaching event later in the year eroded most of those gains. Looking forward, the likelihood of bleaching recurrence suggests that critical role of herbivore management at KHFMA may be in increasing resilience to and recovery from those events.

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MULTI-YEAR SURVEYING OF CORAL REEFS USING AUTONOMOUS UNDERWATER VEHICLES (Abstract ID: 29139)

This talk will present insights gained from the operation of an Australia-wide benthic observing program designed to deliver precisely navigated, time series imagery of the seafloor using Autonomous Underwater Vehicles (AUVs). This initiative makes extensive use of AUVs to collect high-resolution stereo imagery, multibeam sonar, in-situ hyperspectral and water column measurements on an annual or semi-annual basis at sites around Australia, spanning the full latitudinal range of the continent from tropical reefs in the north to temperate regions in the south. We present results of a multi-year survey of reefs impacted by a significant bleaching event, illustrating how the observations provided by the repeat surveys have allowed changes in structural complexity, mortality and growth of individual coral colonies to be tracked through time. We also demonstrate how a small AUV with minimal support infrastructure can be used to generate detailed 3D models covering over 10,000 m2 of reef crest at millimeter resolution. This particular area was subsequently impacted by a cyclone and we will show how this data can be used to document changes in species distributions following a major disturbance event. Finally we will present the outcomes of a multi-vehicle deployment used to collect data across a large coral lagoon, capitalising on the availability of ship time to simultaneously deploy multiple autonomous platforms collecting visual and water column data.

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SIX DEGREES OF BLEACHING: A WEIGHTED LINK REMOVAL MODEL FOR THE CORAL-SYMBIONT MUTUALISM NETWORK (Abstract ID: 28128)

Network analysis and modeling provide a valuable tool for describing the complex interaction between corals and their symbionts. Scleractinian corals and their symbionts can be mapped as a bipartite network. This network consists of nodes of coral species and *Symbiodinium* OTU that are connected by links that represent a mutualistic interaction occurring between them. We present a bleaching simulation model for this network, where we remove links based on calculated temperature thresholds of the mutualistic interactions. The bleaching simulation model iteratively increases the environmental temperature of the network and removes links once their temperature threshold is met. We compared the bleaching simulation model for the global network and networks composed of nodes found in specific oceans to a null model network with randomly assigned weights. The null model started bleaching earlier than the other networks, and then slowed so that all corals were bleached 2°C later than the others. There were significant differences in bleaching rates among ocean basins, with the Pacific network bleaching the fastest. Incorporating specific host and symbiont thermal tolerances into the link weight affects the performance of the network under a bleaching scenario. Network structure affects bleaching resistance, as evidenced in the differences in bleaching behavior among oceans. Differences in network topology play an important role in determining resilience of the coral-symbiont network when faced with increasing sea surface temperatures due to global climate change.

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CORAL REHABILITATION IN SOUTH SULAWESI: HIGH CORAL GROWTH ON SIMPLE MODULAR STRUCTURES (Abstract ID: 27801)

Coral rehabilitation is an important conservation approach in the face of continuing destructive fishing practices in the Coral Triangle, even in Marine Protected Areas. Indonesia, the site of our pilot project, has protected ~32% of its reef habitat; however, much reef habitat is too damaged or disturbed to set aside as MPAs, thus necessitating rehabilitation. We present a pilot coral rehabilitation at Pulau Badi, Spermonde Islands, South Sulawesi. The rehabilitation consists of modular hexagonal frames ('spiders') of epoxy-and-sand-coated rebar secured in the substratum by legs. Coral fragments from

storm and fishing damage (and some from small nursery areas) are secured to the spiders with cable ties. The units allow stabilization of the bottom while providing open water flow around the corals. Approximately 10000 spiders were deployed over 16000 square meters, primarily in long stretches damaged by blast fishing but also in small gaps created by cyanide fishing or other damage. Live coral (primarily acroporid) cover increased from 20% two months after establishment to 82% nearly a year later. Villagers build and help deploy spiders as a supplemental livelihood to fishing, and community engagement and law enforcement to protect reefs have increased, although cyanide fishing of ornamental fishes inhabiting the rehabilitation has become a problem. Currently, fragment supply does not limit rehabilitation but the future goal is to deploy nursery-raised and/or stress tolerant species and to expand the rehabilitation to other sites in the Spermonde Islands.

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LARGE-SCALE, MULTI-DIRECTIONAL LARVAL CONNECTIVITY AMONG GROUPER POPULATIONS IN THE GREAT BARRIER REEF MARINE PARK (Abstract ID: 29092)

Larval dispersal is the key process by which populations of most marine fishes and invertebrates are connected and replenished. Advances in larval tagging and genetics have increased our capacity to track larval dispersal, assess population connectivity, and quantify larval exchange among no-take marine reserves and fished areas. Recent studies have demonstrated that reserves can be a significant source of recruits for populations up to 40 km away, but the scale and direction of larval connectivity across larger seascapes remain unknown. We applied genetic parentage analysis to resolve larval dispersal patterns for two exploited coral reef groupers (Plectropomus maculatus and P. leopardus) within and among regional clusters of reefs separated by 60 – 220 km within the southern Great Barrier Reef Marine Park, Australia. A total of 86 juvenile Plectropomus spp. were genetically assigned to their parents on reefs within the study area. We identified both short-distance (200 m to 50 km) larval dispersal trajectories within regions, and long-distance (50 km to 254 km), multi-directional larval dispersal trajectories among regions. Larval exchange between reserve and non-reserve reefs indicated substantial mixing among management zones and the provision of recruitment subsidies from reserves to fished areas. Our findings suggest that both local-scale self-replenishment and regional-scale connectivity contribute to the maintenance of grouper populations in the Great Barrier Reef Marine Park.

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BASELINES AND DRIVERS OF CORAL DISEASE IN THE WORLD'S OLDEST MARINE PARK (Abstract ID: 28997)

Disease prevalence within a population or community provides an important indicator of ecosystem health; however, its efficacy as an indicator depends on knowledge of baseline levels of disease typical of healthy communities. Here we use Bayesian hierarchical modelling to analyze a 12-year dataset of coral disease prevalence at 42 sites spanning cross-shelf gradients in terrigenous and human influences along 1200 km of the Great Barrier Reef (GBR). Analyses of satellite-derived sea surface temperatures, water quality metrics and wave heights indicate that overall, thermal and water quality stress was relatively mild at study sites from 2004-2015, but with localized cyclone waves. This long-term dataset of coral disease prevalence within a 45-year-old Marine Park provides a unique opportunity to identify baseline levels of disease that characterize comparatively healthy coral reef communities in the absence of extreme environmental stress events. Using median expected prevalence values as baselines, the 95th percentile of posteriors to denote unlikely levels, and the 95th percentile of the data to denote extreme levels of disease, we compare baselines and outbreak thresholds for five common diseases on the GBR. Analyses of 21 model-selected, biophysical covariates that most strongly influence disease prevalence unravel factors potentially driving these patterns. Identification of empirically-derived, shelf-specific disease thresholds signifying moderate and severe disease risk are critical for informed management of factors driving deteriorating coral health.

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INFLUENCE OF NURSERY HABITAT ON THE ABUNDANCE OF A CORAL REEF FISH (Abstract ID: 27834)

The availability of suitable habitat can have a profound effect on the abundance of coral reef fish, particularly those that are habitat specialists. Habitat requirements are however likely to vary with ontogeny, some species associating with specific nursery habitats, and the importance of nursery relative to adult habitats for shaping future abundances remains unclear. Moreover, populations may be influenced by supply of new recruits and any assessment of habitat importance should also consider the effects of supply. We conducted surveys at 16 sites, spanning 200km of the Ningaloo coast, to identify habitat preferences of juvenile, sub-adult and adult damselfish Pomacentrus moluccensis. We then combine information on habitat preferences at different life history stages with six years of information on juvenile abundance and habitat availability to assess the relative importance of habitat and juvenile supply to P. moluccensis populations. Our results show that juvenile habitat at the time of settlement (corymbose corals) is the strongest predictor of future sub-adult and adult P. moluccensis abundance, whilst availability of adult/ sub-adult habitat (branching corals), and changes in juvenile abundance were both poor predictors of future abundance. These findings provide empirical evidence of the value of nursery habitats relative to supply of juveniles and emphasize the importance of identifying and protecting these habitats for the conservation of coral reef fish.

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INTRASPECIFIC VARIABILITY IN LIFE HISTORY TRAITS OF FISHES BETWEEN SHALLOW CORAL REEFS AND MESOPHOTIC CORAL ECOSYSTEMS IN THE CENTRAL PACIFIC OCEAN (Abstract ID: 28258)

Many inhabitants of mesophotic coral ecosystems (MCEs), such as reef fishes, represent a lower depth distribution of their species as they are also found occupying shallow coral reefs in relatively close geographic proximity. Research on fishes associated with MCEs is sparse; hence there is a critical lack of knowledge of how reef fish found at mesophotic depths may vary from their shallow reef complements. We investigated intraspecific variability in growth, reproductive potential and energy partitioning of three Hawaiian endemics collected from shallow, photic reefs and MCEs throughout the Hawaian Archipelago and Johnston Atoll: the detritivorous goldring surgeonfish Ctenochaetus strigosus, and the planktivorous threespot chromis Chromis verater and Hawaiian dascyllus Dascyllus albisella. The von Bertalanffy growth function was used to establish species-specific growth models using otolith-derived ages, and energy investment towards reproduction and body condition was quantified using the gonado-somatic index and Fulton's condition index. Body condition was higher for all species in shallow waters than MCEs; however, variability in reproductive investment between shallow and deep populations differed between species. For all species, fishes from shallow waters reached larger asymptotic lengths than their conspecifics. This ongoing study addresses the life history of coral reef fish, a key component of both shallow and mesophotic reef communities, while providing structure for the development of conservation and fisheries management tools in understudied mesophotic environments.

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ENVIRONMENTAL DRIVERS OF ACCLIMATIZATION: EFFECTS OF GRADUAL WARMING VS. REPEATED THERMAL STRESS ON SYMBIONT COMMUNITY STRUCTURE AND FUNCTION IN REEF CORALS (Abstract ID: 29955)

Both bleaching severity and recovery conditions affect the reassembly of algal symbiont communities during recovery, and incremental changes in community composition can result in increased coral thermotolerance. We investigated how symbiont community composition and coral bleaching thresholds were affected by repeated, short-term thermal stress, both with and without gradual warming. We tested the hypotheses that

episodic temperature stress results in stepwise increases in the abundance of thermotolerant symbionts and that this process is accelerated under gradually warming recovery temperatures. Replicate cores from three colonies of the Caribbean coral *Montastraea cavernosa* were distributed randomly into treatments in a crossed factorial design, experiencing either constant temperature (26°C) or gradual warming (1°C every 6 weeks), and either short-term thermal stress (32°C, target ~25% symbiont community loss) or no bleaching. Symbiont community function was tracked using chlorophyll fluorometry, and tissue samples taken periodically were analyzed using actin-based qPCR assays to determine symbiont community composition. All cores were subjected to a final bleaching stress at 32°C to assess thermotolerance. This experiment will elucidate how gradual warming and punctuated bleaching stress affect symbiont community composition and drive changes in coral thermotolerance, and has implications for the response of reef corals to real-world warming scenarios.

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PRIORITIZING SUITABLE CORAL RESTORATION SITES THROUGH ASSESSMENT OF EXISTING CORAL MONITORING DATA (Abstract ID: 28793 | Poster ID: 535)

In the face of large scale coral reef decline, restoration efforts are increasing throughout the Florida Reef Tract. The general focus of these efforts is restoring Acropora cervicornis populations. Currently, there is little to no spatially explicit information regarding site prioritization for coral restoration efforts in Florida, where most restoration sites are selected using expert opinion alone. This study is the first step towards using spatially explicit information to guide restoration site selection in Florida. A species distribution modeling approach was taken to spatially prioritize restoration efforts along the Florida Reef Tract. A series of non-parametric species distribution models (SDMs) were constructed using species richness, coral cover, and A. cervicornis data. These SDMs were combined with other spatial data in the conservation software "Zonation" to prioritize restoration sites based on connectivity, species interactions, and health. The results of this work is an interactive tool that can be adjusted to support the unique goals of individual restoration projects.

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ASYMMETRIC, LARGE SCALE COMMUNITY RESPONSES TO CLIMATE OSCILLATIONS IN GALAPAGOS SUBTIDAL ECOSYSTEMS (Abstract ID: 29048)

Climate events such as El Nino Southern Oscillations (ENSOs) can drive ecosystems to a tipping point as thresholds are exceeded and a sudden transition to a different state (regime) occurs. We monitored benthic communities and oceanography in Galapagos rocky subtidal ecosystems at 12 sites for 14 to 17 years to test the hypothesis that ENSO's create non-linear effects leading to a regime change. Extensive bleaching of massive (Porites, Pavona) and branching (Pocilloporid) corals occurred during the La Nina phase of the 2006-2008 ENSO and again, during the 2010 to 2011 La Nina in response to unusually large temperature variability (30.0 -14.0 degrees C). Surprisingly, large increases in barnacle (Megabalanus) abundance coincided with coral bleaching during both La Ninas, suggesting higher barnacle recruitment during these productive periods. The asymmetric yin yang of ENSO effects was apparent in the negative impacts on corals via bleaching but positive, bottom-up effects on benthic food webs dependent on the large barnacles. Barnacle abundance on rock walls attained maximum abundances of 60 to 80 % cover at some sites in recent years concomitant with a greater proportion of corals overgrown by barnacles, suggesting a shift to a regime characterized by declining coral populations and increasing barnacles and their predators. Community responses of the most recent 2016 ENSO will be analyzed in the context of these hypotheses.
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EVALUATING THE QUALITY OF A LONG TERM CULTIVATION EXPERIMENT OF *OPERCULINA COMPLANATA* BY COMPARISON WITH THE NATURAL LABORATORY APPROACH (Abstract ID: 28635 | Poster ID: 290)

Larger benthic foraminifera contribute largely to the carbonate reef budget and are great tools in biostratigraphy. During the last decades they also got importance as indicator species for ecological monitoring. Even before their advancement as bioindicators, laboratory experiments have been conducted to investigate their biology, ecology and reproduction. While recent studies have focused on the effects of single ecological parameters mostly in short term culture experiments (few days to some weeks), the majority of results still shows growth abnormalities and truncated lifespans even in control groups, indicating some imperfections in the culturing systems, which hardly represent open water conditions. Therefore, to fully understand growth and life span of different species and to improve their use in various fields, long term cultivations attempts must be conducted trying to get the perfect equilibrium between cells and environment. This study presents theoretical growth models of *Operculina complanata* based on a 15 month cultivation experiment with 186 specimens and compares them to first results of the equally long Natural Laboratory Approach both conducted at Sesoko station (Okinawa, Japan). Culturing parameters such as temperature, light intensities, salinity and pH and light-dark duration were continuously adapted according to the measurements in the field. The average cell life time in culture was 77days, 13 Individuals lived more than 200 days, 3 reproduced asexually and one sexually, 14% of the individuals were lost and 22% died within the first month.

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FISHING ENDANGERS THE TROPHIC STRUCTURE OF THE CORAL AND SHARK DOMINATED SYSTEM OF THE WOLF AND DARWIN ISLETS (GALAPAGOS): INSIGHTS FROM MODEL SIMULATION (Abstract ID: 27815)

The Galapagos archipelago is known for its great diversity in marine species distributed over distinct biogeographic regions. We hypothesized that these regions not only differ in species and/or their relative abundances, but also in overall biomass and resource productivity with implications for fisheries management and conservation. We thus modeled and compared the trophic structure of the south western Bolivar Channel (BC) upwelling system and the coral dominated northern system of the Darwin and Wolf (DW) islets using the Ecopath with Ecosim approach. Results indicate that the BC very much resembles classical upwelling systems off the coast of Peru with high primary production, low level of maturity, high biomass at lower trophic levels, high energy flow, and sea lions as dominating top predators. The coral reef dominated system (DW), to the contrary, showed a more complex food web structure, a higher degree of system maturity and a concentration of fish biomass in large predators (55%) that were identified as keystone species largely controlling intermediate predators. By using the reference models of both systems to explore the effect of increased fishing pressure, a negative impact was pronounced in the coral DW system, where the increased removal by herbivore controlling fish, would eventually lead to an alternative system state with sea urchins dominating the benthic biomass. We argue that an increase in fishing pressure in the presently still semi-pristine coral and shark dominated northern area of the archipelago (DW), would easily lead to loss of one of the most unique ecosystems of Galapagos and propose strong conservation enforcement for the DW region.

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VULNERABILITY OF THE GREAT BARRIER REEF TO GLOBAL AND LOCAL PRESSURES: IMPLICATIONS FOR EFFECTIVE MANAGEMENT AND POLICY DECISIONS IN A WARMING OCEAN (Abstract ID: 29087)

The Great Barrier Reef (GBR) has lost half of its coral cover during the past thirty years, attributed predominantly to storms, crown-of-thorns starfish (COTS) and, to a lesser extent, bleaching. Two questions at the core of GBR management plans are: how vulnerable and resilient will the GBR be to future environmental scenarios, and what will the relative importance be of different local or global disturbances? To answer these questions we use a spatially explicit model of coral cover dynamics (mortality and growth) parameterized by four input functions: warming, storms, water quality and COTS. Using a series of 8 scenarios representing combinations of climate change (based on three AR5 global circulation models) and local stressors, we analyse spatial and temporal trends and uncertainties associated with future impacts. Our results demonstrate that coral resilience will decline in pace with climate change under all three RCPs. Local and regional management actions (land-use management, COTS control, spatial planning) can compensate for this resilience loss on some reefs in the near-term (10 – 20 years), but by 2050 these actions can no longer mitigate the loss imposed by climate change. The implications of these results for management and policy decision problems are discussed, particularly the need to better acknowledge and account for the limits of local scale action when dealing with the global problem of climate change.

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HAWAIIAN POCCILOPORA DAMICORNIS BABIES LEAD THE WAY TO REEF RESTORATION (Abstract ID: 28109 | Poster ID: 484)

Innovative techniques for restoring coral reefs have been a continuous conversation among scientists, politicians, and government officials for decades. The ability to develop and implement coral transplantation techniques without harvesting existing reef corals can maintain a reef's ecological value. Monthly collection of planula from colonies of Hawaiian Pocillopora damicornis have been successfully maintained, and settled, and the resulting colonies used as source material for mitigation projects. Frequent asexual planulation (versus sexual propagation) provides an abundant supply of coral to be used in improving reef restoration techniques. P.damicornis planula have the potential to pave the way for other restorative corals by providing further insight for successful transplantation, artificial substrate preferences, re-aggregation of identical genotypes, and threshold tolerances to anthropogenic stressors and climate change. Replicate experiments in large quantities can be used to evaluate reef restoration trade offs such as the cost required to transplant corals onto a reef versus the effort to transplant individual colonies. This plentiful resource holds the potential of becoming the new "lab rat" for reef experimentation while at the same time providing critical source material for reef restoration.

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CORAL ISOSCAPES REVEAL VARIED NITROGEN SOURCES AND DYNAMICS IN HONG KONG'S COASTAL ENVIRONMENT (Abstract ID: 29155 | Poster ID: 92)

Hong Kong's marine ecosystem health is under threat due to large inputs of dissolved inorganic nitrogen (DIN) from various sources. We used stable isotope analysis to trace major DIN source(s) affecting corals and examined their spatial and temporal variations in coastal environments. We collected corals along coastlines in a wet and dry season and analyzed the $\delta^{15}N$ signals of their *Symbiodinium* ($\delta^{15}N_s$). Spatially, the mean $\delta^{15}N_s$ value was significantly lower in the Southern zone–SHK (5.6±1.5‰) than Northeastern zones–PS (8.0±1.1‰) and MB (8.8±1.3‰) in the wet season. In the dry season, there was no significant difference in the mean $\delta^{15}N_s$ values among zones. When compared between seasons, the mean $\delta^{15}N_s$ value in SHK in the dry season (6.9±0.7‰) was significantly higher than the wet season. The spatial and seasonal differences in the $\delta^{15}N_s$ values highlighted the influence of the Pearl River (PR), which supplies Hong Kong with a high concentration of $^{14}N$ compared to N derived from oceanic water. The dominance of N from PR could contribute to the low $\delta^{15}N_s$ values in SHK in the wet season as it is in close proximity to PR. The seasonal difference, i.e. higher $\delta^{15}N_s$ values in SHK in the dry than wet season, can be explained by the decreasing influence of PR as the dry season accounts for ~20% of the annual discharge. These data suggested PR has a major influence to the DIN dynamics and its significance is subject to spatial and seasonal changes.

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EFFECT OF COMPETITION ON GROWTH AND FITNESS OF *SYMBIODINIUM* POPULATIONS IN CULTURE (Abstract ID: 29175)

According to the resource-ratio hypothesis, autotrophs with a lower minimum nutrient requirement will tend to dominate, as they further reduce nutrient availability to competitors, thus leading to dominance via competitive exclusion. With the use of bioreactors, minimum nitrogen and light requirements for *Symbiodinium* can be quantified and used to predict competitive outcomes among clades that co-occur in host corals. However, competitive outcomes are likely influenced by physical factors such as temperature and light, which can impact metabolic rates. Thus, a species may only be a superior competitor for limiting nutrients within its thermal or irradiance optima. We show that temperature drives different competitive outcomes in mixed cultures of *Symbiodinium* clades D and A. Clade D was always displaced by clade A, but more so at 32˚C (D:A cell ratio = 0.00), than at 26˚C (0.02) after 33 days of competition. In co-dominant populations, a slightly reduced photosynthetic efficiency (YII=0.376) was observed in comparison to pure cultures (YII=0.399). We hypothesis that reduced YII is a consequence of resources being allocated to competition and fewer to beneficial metabolic traits. The cost of hosting competing *Symbiodinium* populations might explain the rarity of mixed *Symbiodinium* populations *in situ*.

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EVIDENCE OF REPRODUCTIVE PLASTICITY OF PORITES ASTREOIDES ACROSS A DEPTH GRADIENT IN BERMUDA (Abstract ID: 28378 | Poster ID: 183)

Mesophotic coral reef ecosystems (MCEs) extend to the bottom of the photic zone and are relatively sheltered from anthropogenic and natural disturbances resulting in low reef degradation compared to shallow reef counterparts. MCEs are hypothesized to serve as a refuge for shallow reefs, where larvae may aid the re-population of previously disturbed shallow habitats. This study determines whether upper mesophotic Porites astreoides can function as a reproductive refuge for shallow reef environments by (1) comparing patterns in lunar periodicity, fecundity, and differences in larval sizes between 10 m and 30 m colonies, and (2) testing whether there is a significant difference between larval settlement success in laboratory settings in July and August 2015. Shallow colonies released more larvae than upper mesophotic colonies in July, while the opposite pattern was observed in August. In August, the shallow colonies released significantly larger larvae than the upper mesophotic colonies, however this did not hinder metamorphosis as larval settlement rates did not differ with parental depth. These results indicate that upper mesophotic P. astreoides produce viable larvae that are able to colonize available substrates at similar rates to shallow larvae. In conjunction with vertical connectivity studies, our results suggest that upper mesophotic P. astreoides may be able to serve as a reproductive refuge for shallow water environments.

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A CATASTROPHIC CORAL DISEASE OUTBREAK IN HONG KONG THAT MAY BE ASSOCIATED WITH HARMFUL ALGAL BLOOMS (Abstract ID: 29483)

A rare massive outbreak of coral disease took place in March 2015 in Tolo Harbour and Channel, a eutrophied semi-enclosed embayment in northeastern Hong Kong. The disease was first noticed by abnormal extensive protrusion of mesenterial filaments or tentacles from affected coral colony surfaces. Rapid tissue loss quickly followed, with a pattern closely resembled white syndrome. In tissues of diseased lesions, ciliates were observed. Field survey registered a loss of 20.6-51.4% in total coral cover in five locations, three of which were within marine protected areas. Coral communities of closer proximity to water discharge in inner Tolo Harbour were more impacted. *Platygyra* spp., the locally dominant corals, suffered the highest morality when compared to *Acropora* spp., with the latter being generally shown to be more vulnerable to stresses and diseases. Experimentally, healthy coral tissue could be induced to exhibit lesion by exposing to water previously used to incubate diseased corals. Ciliates were always present in the coral lesion even the water was filtrated and autoclaved. Presence of toxin in the water was therefore the likely cause of lesion and the source of this toxin could have been the harmful algal blooms of *Heterocapsa circularisquama* and *Noctiluca scintillans* that broke out a bit earlier. The latter bloom attended the highest density (21500 cells/ml) ever recorded since monitoring started in 1977. There could therefore be a close association between eutrophication, algal bloom and coral diseases. Project supported by RGC GRF 460013.

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LINKING LAND AND SEA THROUGH AN ECOLOGICAL-ECONOMIC RECREATION MODEL (Abstract ID: 30134 | Poster ID: 587)

Coastal and marine systems provide key ecosystem goods and services that support human well-being. Despite their importance for Hawaii's economy, many of these services are declining due to land-based stressors, such as nutrient runoff, pollution, and sedimentation. These stressors are expected to worsen with increasing climate change and development, resulting in ecological, cultural, and economic benefits loss. To support an integrated land-sea approach to management and planning in a priority watershed in West Maui, we are building a Bayesian network-based recreation model to link a sedimentation model and land-based sources of pollution with the social and ecological factors that influence recreationists' preferences for snorkeling sites. Employing a discrete choice experiment (DCE), we evaluated preferences and willingness to pay for six coastal site attributes. We are linking non-market economic values with ecological attributes to assess ecological, economic, and cultural gains and losses under different climate change and management scenarios. Preliminary DCE results suggest that recreationists positively value benefits in terms of increased biodiversity and recreation opportunities, as well as reductions in pollution and health risk. Our results are expected to inform strategic planning for integrated ridge to reef management that strengthens both socioeconomic and ecosystem health.

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APPLYING SOCIAL SCIENCE TO UNDERSTAND THE WELL-BEING OF REEF-DEPENDENT COMMUNITIES IN MICRONESIA (Abstract ID: 28110)

The importance of social science for generating management-relevant information about the uses and impacts of human activities on coral reef and other coastal resources is now recognized. In recent years, the use of social scientific methods has been expanded to include research that examines how people benefit from natural resource management and conservation intervention, a key objective that increasingly has been adopted by conservation organizations and coastal resource management agencies across all geographical areas. Social scientific methods are being employed to help develop indicators to better understand linkages among changes in biological and physical conditions, ecosystem services, and human well-being. This presentation examines efforts and activities in Micronesia related to the use of social science identifying the most important human well-being indicators for the region, as well as the opportunities and challenges involved in implementing social scientific research. The presentation will also highlight in particular the NOAA Habitat Blueprint focus area in Guam and how social science is being employed in designing socio-ecological research that examines impacts of sedimentation on reefs as critical habitats and on fisheries as a means of livelihood and cultural heritage.

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BIOEROSION BY THE SEA URCHINS ON CORALS IN THAILAND (Abstract ID: 30031 | Poster ID: 84)

Sea urchin is one of the most abundant bioeroders in coral reefs in Thailand. In this study, the bioerosion on a staghorn coral Acropora millepora (Ehrenberg, 1834) by the sea urchin Diadema setosum (Leske, 1778) was investigated. Both field surveys and experiments were conducted. From the field surveys at Chon Buri Province in the upper Gulf of Thailand, the highest abundance of sea urchins was approximately 11 individuals m-2. The results from the stomach contents showed that there were significant amounts of calcium carbonate found in the sea urchins' stomachs. In addition, two experiments were conducted to investigate the interaction between sea urchins and corals and the interaction between sea urchin, corals, and algae Cladophora sp. The results of the interaction experiment without algae showed that bioerosion rates of one sea urchin were approximately 0.20 g day-1 and 1.59 cm-2 day-1 in term of CaCO3 and area respectively, which were higher than that of with algae. There were also correlations between the densities of sea urchins, sizes of sea urchins, and the bioerosion rates. However, after the experiments, we found that most corals bioeroded by the sea urchins can recover within 14 days.
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EL NIÑO, SURFACE CIRCULATION AND CORAL LARVAL DISPERSAL ACROSS THE WORLD'S GREATEST MARINE BARRIER (Abstract ID: 29457)

Over 5000 km separates the frequently disturbed coral reefs of the Eastern Tropical Pacific (ETP) from western sources of population replenishment. However, the presence of trans-Pacific corals in the ETP implies that some species have, at least historically, breached this 'East Pacific Barrier' (EPB). It has been proposed that increased eastward flow during El Niño facilitates cross-Pacific dispersal into the region. However, direct evidence is lacking in corals. We present output from a biophysical dispersal model, employing the Connectivity Modelling System (CMS), driven by 15 years (1997-2011) of high resolution oceanographic data. The model is parameterised to represent the positively buoyant larvae of a generic broadcast spawning coral with high dispersal potential. No eastward cross-Pacific connections occurred over the modelled period, which encompasses a range of climatic variability, including the extreme 1997-98 El Niño. We infer that ETP populations decimated by this event have therefore likely recovered from local sources. Instead, rare connections between eastern and central Pacific reefs were simulated in a westward direction. Significant complexity in the surface flows transporting larvae mean that generalised upper-ocean circulation patterns are poor descriptors of inter-regional connectivity, complicating assessments of how climate change will impact coral gene flow Pacific-wide. We discuss efforts to incorporate the effects of temperature on larval development in the biophysical model in order to make more accurate projections of future dispersal.

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CORAL ZOMBIES: ASSESSMENT OF REPRODUCTIVE CONDITION IN ACROPORA PALMATA ACROSS THE U.S. CARIBBEAN (Abstract ID: 29781)

Reproductive failure in Caribbean Acropora has been identified as a critical factor in their Endangered Species Act (ESA) listing and in preventing the species' recovery. Previous work on Acropora palmata (elkhorn coral) reproductive condition indicates that visually intact and 'apparently healthy' colonies can in fact carry mild to severe reproductive pathologies. A total of 34 sites across the U.S. Caribbean, were surveyed two weeks prior to spawning in 2013, to determine the reproductive condition of A. palmata populations from histological examination of tissue biopsies. The survey included Florida, Puerto Rico, and St. Thomas, St. John and St. Croix in the U. S. Virgin Islands, resulting in biopsies from 327 colonies. The reproductive effort of A. palmata ranged from 0% effort in two Florida reefs and two St. Croix reefs to 100% at one St. John, USVI reef. The Caribbean-wide assessment of the reproductive effort of A. palmata identified populations that are reproductively viable, indicating healthy 'resilient' populations, and those that are impacted. This work has identified key locations where further management actions are needed to promote species recovery and provides the first step in an epidemiological approach to understanding drivers of decline in certain populations, as well as populations warranting heightened protection (resilient populations).

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MICROATOLLS AS INDICATORS OF SEA-LEVEL CHANGE ON REEFS (Abstract ID: 28523)

A major outcome of the Great Barrier Reef expedition in 1973, and David Stoddart's research during it, focused on detecting changes in sea level. Together with Terry Scoffin, he described living and fossil microatolls from the Great Barrier Reef and recognised their significance as sea-level indicators. In the four decades since, changes in sea level associated with global climate change have become a focus of considerable concern, particularly in relation to the small reef islands throughout reefal seas. Accurately surveyed and dated Porites microatolls provide considerable insight into past water level changes, especially where their elevations can be compared to living modern equivalents. These long-lived massive corals, up to 9 metres in diameter, preserve a biologically-mediated multi-decadal record of sea-level. The upper surface of fossil microatolls on a reef flat generally lies in a narrow elevation range similar to that observed for their modern, living counterparts. This paper examines the insights that Stoddart provided and assesses how microatoll morphology is likely to respond to future sea-level changes.

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ENVIRONMENTAL FACTORS LIMITING FERTILISATION AND LARVAL SUCCESS IN CORALS (Abstract ID: 29181 | Poster ID: 530)

Early life history stages of reef-building corals, specifically fertilisation and larval survival, are susceptible to changes in the chemical and physical properties of seawater. Quantifying how changes in water quality affects these stages is therefore important for understanding and predicting population establishment in novel or changing environments. A review of the literature identified that levels of salinity, temperature, pH, suspended sediment, nutrients, and heavy metals affect coral early life history stages. Using published experimental data, this study quantified the influence of these seawater properties

on coral fertilisation and larval survivorship probabilities. Fertilisation success was highly sensitive to salinity, copper, phosphorous and suspended sediment. Larval survivorship was sensitive to copper, lead and temperature. A combined model was developed, to estimate the joint probability of survival through fertilisation and larval survivorship. This model was able to determine the likelihood of larvae surviving through each stage of development to settlement competency, as well as incorporating real life data from Sydney and Lizard Island in Australia. This combined model could therefore be used to recommend targets for water quality in coastal waterways as well as aid in predicting the potential for species to expand their geographical range in response to climate change.

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PRELIMINARY MEASUREMENTS OF CORAL COMMUNITY LIGHT-USE EFFICIENCY IN RESPONSE TO VARIABLE ENVIRONMENTAL CONDITIONS (Abstract ID: 28716)

Primary production is arguably the most important ecological function of corals. Primary production is strongly driven by ambient light levels, confounding interpretation of day-scale productivity measurements. Light-use efficiency (LUE) normalizes primary production by removing the light-engendered variability. Our objective was to determine how environmental conditions affect the LUE of a coral community. We placed a community of*Porites astreoides* inside a flume mesocosm, where we controlled irradiance and flow speed during four trials: (1) control, (2) elevated temperature, (3) elevated nutrients, and (4) elevated CO2. During each trial, we measured daily gross primary production (P) and daily absorbed photosynthetically available radiation (APAR), then calculated LUE as P ÷ APAR. Relative to control conditions, there was no significant change in LUE with elevated temperature or CO2, but LUE did decrease significantly under elevated nutrient conditions. Though it was not explicitly manipulated, there was a statistically significant negative correlation between LUE and salinity, which increased as a by-product of the nutrient treatment methodology. Further research is required to more definitively characterize the effects of larger changes in each of the environmental parameters, but these preliminary data demonstrate the potential utility of applying LUE to evaluate an important aspect of reef ecosystem function.

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LOOKING THROUGH A MICROSCOPE BRIGHTLY! TISSUE CHANGES SHED LIGHT INTO PATHOGENESIS OF DISEASE AND ECOLOGICAL PROCESSES IN CORAL REEFS. (Abstract ID: 28218)

Understanding what drives coral reef health and kills animals associated with coral reefs will be critical to maintaining healthy reefs. By revealing morphologic changes at the cellular level such as inflammation or presence of microorganisms, histology has provided important insights into health of various organisms associated with coral reefs in the Pacific. For instance, we now know that the herpesvirus associated with fibropapillomatosis, a tumor disease affecting sea turtles globally, is shed mainly in small tumors, and that only a few affected turtles (superspreaders) are likely responsible for a majority of disease transmission. Skin lesions in surgeonfish, thought to be a normal color variant, have turned out to be pigment cell tumors. A die-off of collector urchins on Oahu was likely associated with viral-like particles infecting inflammatory cells. Finally, histology is beginning to explain various phenomena in coral diseases such as dark spots (overgrowth of fungi), tissue loss (associated with parasitic corals, ciliates, fungi, algae, and cyanobacteria), and growth anomalies. Microscopy might even prove useful in explaining ecological patterns. We have found that dominant Porites, Acropora, and Pocillopora have a high prevalence of tissue-associated bacterial symbionts that could provide competitive advantages and explain their dominance on reefs. Microscopic morphology of corals might also even aid coral taxonomy by revealing tissue structures unique to certain species. Many new discoveries await those willing to peer through the looking glass.
http://www.nwhc.usgs.gov/hfs/

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DEALING WITH CORAL REEFS RISK AND DECISION MAKING IN THE FACE OF CLIMATE CHANGE AND DEVELOPMENT NEEDS (Abstract ID: 29465)

New dimensions of environmental resource value and loss will increasingly become a key feature on the government balance sheet in coral reef regions .Forecasting expected losses of critical environmental functions provided by reefs is setting new challenges for scientists.International investors wrestle with the dollar value of risks of frontier tropical ecosystems which affect stakeholder confidence .Efforts to develop “state of the art” techniques to quantify coral reef ecosystem services will be presented plus a critique of how these support decision making. Advances in GIS and satellite imagery illustrate the future opportunities to measure regional ecosystem changes. A series of case histories will illustrate approaches to dealing with risk to marine assets revealing dimensions of resource risk exposure, risk reduction and future liabilities. Our understanding of the role of biodiversity; reef system robustness; recoverability; habitat uniqueness; species life cycles in the sustainability of reef services will be reviewed and reveals fundamental gaps in knowledge. The global efforts being made to place $ values on the world’s natural capital and tropical ecosystem life support services will be summarised. A pioneering approach to environmental due diligence of investments, eco risk assessments will be presented. Insights will be given on the latest techniques for mapping environmental resources and services in integrated GIS systems on the web, which will provide a “reef ecosystem health thermometer” making key services visible to stakeholders.

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A NEXT-GENERATION APPROACH TO SPECIES DELIMITATION IN THE SPECIOSE OCTOCORAL GENUS, SINULARIA (Abstract ID: 28271)

Sinularia is a speciose clade (~180 described species) of octocorals that dominates primary substrate in shallow coral reef communities throughout the Indo-Pacific. Like other zooxanthellate corals, Sinularia is highly susceptible to bleaching, and mass mortality events have been recorded throughout its range. Attempts to better understand the ecology of Sinularia-dominated communities are hindered by the difficulty of delineating species. Molecular markers and associated morphological synapomorphies divide the genus into five major clades, but within clades a marked lack of congruence between morphological and molecular characters leads to conflicting evidence for species boundaries. To date it is not clear if this conflict is due to the relative invariability of the mitochondrial markers typically used for species discrimination or to a lack of understanding of the range of intraspecific morphological variability in the genus. To address this issue, we used a RADseq next-generation sequencing approach to delineate species boundaries among 14 putative morphospecies in which molecular identity is often in conflict with morphology. The majority of the specimens analyzed were collected from a single site in the South China Sea (Dongsha Atoll) where a mixed assemblage of Sinularia species covers >80% of the shallow forereef. Delineation of species based on the RADseq data has allowed us to assess the reliability of single-locus mt haplotypes for species discrimination in Sinularia, and to identify genetic clades that exhibit high levels of morphological variability.

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POPULATION GENETICS OF HUMPHEAD WRASSE (CHEILINUS UNDULATUS) IN ANAMBAS ISLANDS, INDONESIA BASED ON D-LOOP MITOCHONDRIAL DNA (Abstract ID: 28803)

Overfishing is the main threat of coral reef biodiversity on the planet. One of the threatened species is the humphead wrasse (Cheilinus undulatus) which also known as the napoleon wrasse, is mainly found on coral reefs in the Indo-Pacific region. Listed as an ‘endangered’ species on the IUCN Red List, the major threat to this species is live reef food fish trading (LRFFT) exports to Hong Kong and South China. Anambas, Indonesia has long been a center of export for humphead wrasse and groupers. This trade is primarily composed of wild-caught adult individuals, but over time stocks have become severely overfished and adults in the wild have become nearly impossible to find. Here, we investigate the population of C. undulatus in Anambas and reveal the genetic relationships of adults from captivity with juveniles in the wild through a portion of the mitochondrial DNA region known as the D-loop. In 2013, seven adults of C. undulatus were collected from captivity in Air Sena and Tanjung Patinting and 50 samples of the juveniles were collected from Air Asuk and Batu Belah. Our results show that among 19 haplotypes, haplotype 1 was predominantly found in Air Asuk and Batu Belah. Thus, the remaining juveniles were from haplotypes of the adults from captivity other than in Air Sena and Tanjung Patinting. This haplotype network will provide a better understanding of whether there is a natural semi-closed aquaculture system in Anambas and further for the conservation management of humphead wrasse, particularly in that region.

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SPONGE DIVERSITY ON CORAL REEFS: PHYLOGENETIC SIGNAL IN RESPONSES TO PROCESSES THAT DRIVE DIVERSITY PATTERNS (Abstract ID: 30071)

Sponges do not conform with geographic-scale species diversity patterns illustrated by corals and other coral reef organisms: region-wide sponge species diversity is similar among ocean basins, and local diversity is revealed to be similar among locales whenever a variety of sites are sampled. Lack of conformity may reflect the broad range of growth forms, internal morphologies, propagative strategies, chemical characteristics, skeletal properties, and symbiont associations displayed by members of the at least 20 sponge orders that inhabit coral reefs; and the consequently broad range of ecological requirements and vulnerabilities of sponge species. We have been evaluating processes driving diversity patterns by experimental additions of species to sites from

which they were absent, and by monitoring sites through time in sufficient detail that diversity changes can be confidently ascribed to particular abiotic or biotic events. The latter entails time-series volume measurements of every sponge of every species in permanent plots. During the last 30 years, our long-term census plots at four Caribbean sites have experienced temperature anomalies, dense phytoplankton blooms, disease, changes in predator populations, and storms; resulting in data on how over 80 species are influenced by these factors. Simple tallies of number of species do not tell the important stories about sponge diversity. Analyses of phylogenetic signal in responses to environmental challenges reveal a troubling coincidence of beneficial functional roles played on coral reefs and diversity losses.

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THE OUR FLORIDA REEFS COMMUNITY PLANNING PROCESS: COLLABORATIVE MANAGEMENT ACTION DESIGN TO INFORM THE CONSERVATION OF SOUTHEAST FLORIDA'S CORAL REEF ECOSYSTEM (Abstract ID: 28859)

The Our Florida Reefs Community Planning Process is an unprecedented opportunity for community engagement in marine resource management in the State of Florida that has brought together local residents, reef users, business owners, visitors and the broader public in southeast Florida to identify actions that should be taken to strengthen coral reef conservation and management in the region. This area, which is inhabited by more than 6 million residents with an additional 30 million tourists visiting each year, lies adjacent to the northern third of the Florida Reef Tract. Our Florida Reefs (OFR) was designed to increase public involvement in the management of southeast Florida's coral reef ecosystems by facilitating a collaborative process with community members to develop recommendations that will become part of a comprehensive management strategy to ensure healthy coral reefs in the future. Community Working Groups consisting of local residents, reef users, business owners, scientists, and representatives from NGOs and local, state, and federal agencies worked together to developed recommended management actions through a 2 year collaborative planning process. The outcomes of OFR will provide the State of Florida with a strategic policy framework for the integrated management of coral resources along its southeast coast. Planning and implementation of OFR is a partnership between Florida Department of Environmental Protection and NOAA's Coral Reef Conservation Program.
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ECOLOGICAL AND BIOGEOCHEMICAL IMPACTS OF INTERNAL WAVES ON MESOPHOTIC CORAL ECOSYSTEMS: TESTING EDDY CORRELATION AND ISOTOPE APPROACHES, IRIOMOTE, JAPAN (Abstract ID: 28489)

While mesophotic coral ecosystems (MCE) may be protected or damped from disturbances impacting shallower reefs insufficient information is available on the environmental conditions supporting these 'deep water refugia'. Nutrient inputs and recycling have rarely been quantified over MCE but may differ fundamentally to that of shallow counterparts due to the reduction in light and increasing reliance on oceanic nutrients, leading to increased heterotrophy over autotrophy at species and ecosystem levels and stronger links to oceanic processes. For instance, due to the depth of MCE relative to typical water column density stratification, internal waves may be a highly significant process depending on community aspect and exposure. Preliminary observations of MCE along a continuum of oceanic exposure in Funauki Bay, Iriomote, Japan indicate that ocean-exposed MCE are subject to semi-diurnal temperature oscillations of up to 4 C during summer (range 23 – 29 deg C), while inner MCE occur shallower in more turbid but stable environments. Oceanic exposure along the bay may determine both the distribution and function of spatially extensive, but relatively homogenous, communities dominated by Leptoseris sp. or Acropora ? horrida. Combining bulk and compound-specific stable isotope analyses, depth-specific radioisotope markers such as radiocarbon, and eddy correlation experiments in these habitat promises a useful approach for elucidating the functional importance of internal waves in the development and persistence of MCE at local to regional scales.
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SWITCH FROM AUTOTROPHY TO MIXOTROPHY IN SYMBIODINIUM: GLUCOSE MODULATION OF PHOTOSYNTHESIS AND SYMBIOSIS (Abstract ID: 29029)

The mutualistic symbiosis between Symbiodinium and its cnidarian hosts provides the metabolic foundation for biodiverse coral-reef ecosystems, but many details of nutrient exchange between host and alga remain unknown. Here we show that when cultured in the presence of glucose in the light (10 μE) (mixotrophic growth), clonal Symbiodinium strain SSB01 loses pigmentation and photosynthetic activity, whereas little loss of pigmentation occurs during growth on glucose in the dark. Mixotrophic cells also lose thylakoid membranes, accumulate lipids, alter their cell surface, and show little ability to infect either larval or aposymbiotic adult Aiptasia (anemone) hosts (suggesting that algal photosynthesis may be important for uptake or retention by the host). Despite these changes, the alga exhibits rapid growth on glucose in either the light or dark. When bleached cells are returned to medium without glucose, they regain pigmentation, photosynthetic activity, photoautotrophic growth and the ability to infect the host. To elucidate how glucose modulates SSB01 physiology, we used RNA-seq and RT-qPCR to characterize changes in global gene expression during both bleaching and recovery. We found that levels of transcripts for proteins associated with photosynthesis, carbohydrate metabolism, and cell adhesion declined in glucose-bleached cells, suggesting that modulation of transcript abundance upon addition of glucose to photoautotophically-grown cultures reflects certain physiology changes that allow the transition from a photoautotrophic to a mixotrophic life-style.

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WAITING FOR RECRUITMENT: RESILIENCE WITHOUT RECOVERY IN THE LAKSHADWEEP ARCHIPELAGO (Abstract ID: 28632)

Determining the resilience of reefs to increasingly severe climatic events will be critical for their effective management. There is growing evidence that resilient reefs are characterized by high levels of herbivory–essential for mediating algal growth–and the availability of stable structure for new coral settlement. After a coral mass mortality in 2010, we monitored 9 shallow reefs in the Lakshadweep to determine if our assessment of their resilience capacity was reflected in recovery five years later. Although most reefs showed high herbivory rates and had suitable recruit settlement structures, recovery was slow across the archipelago. From 2012-2015 coral cover in permanent quadrats increased by a maximum of 1.5% per year. This contrasts with recovery trajectories after the 1998 ENSO mass mortality, where coral cover increased by 7% annually at these reefs, driven primarily by species of Acropora. In contrast, post-2010, coral juveniles were nearly three times less abundant at these reefs. Recovery, where observed, was driven by a single species (Pocillopora verrucosa). This compositional shift can have important consequences for the structural complexity and community assembly in these reefs. Our results suggest that despite having several factors necessary to guarantee resilience, the absence of banner years of coral recruitment post-disturbance may seriously limit current reef recovery trajectories across the Lakshadweep Archipelago. Identifying and protecting potential sources of coral larvae will be critical to translate this high resilience into quick recovery.

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GAPS BETWEEN FUTURE DISTRIBUTION OF CORALS AND MARINE USE/SPATIAL PLANNING AROUND JAPANESE ARCHIPELAGO. (Abstract ID: 28499)

After the adoption of the Aichi Target 2010, protected areas are rapidly expanding in Japan. It is also true in coastal areas such as the Pacific side of the northern part of the main island (Sanriku) and Southern islands in Okinawa. However, most of them did not consider the effect of climate change to decide their conservation target. Here we evaluated the potential distribution of the reef-forming coral species, such as Acropora

spicifera and Acropora solitaryensis, which compose coral communities around their northern limits in the Pacific.. We projected future distribution of these species using outputs of statistical models based on future sea surface temperature (SST) data derived from climate models. We also collected data on the use of the coasts, including fisheries right areas and areas with marine leisure activities the latter of which was represented by the number of dive shops. The distributions of the coral species are highly constrained by the lowest SST and would potentially expand to the north within 50 and 100 years. The response curves of presence of the corals to the SST agreed well with the experimental results on the tolerance to SST. A comparison with the present use (diving shops) of the coral reefs showed there were significant differences between the use of the corals for leisure activities and the distribution of the species even in the present situation. Considering the future distribution, potential conflicts between the present fishery use and coral expansion was suggested. We will discuss suitable configurations of proposed marine protected areas considering these dynamics and conflicts under several different conservation targets.

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INTENSIVE CORAL REEF RESTORATION TECHNOLOGY BY APPLYING LARVAL SUPPLY BASE (Abstract ID: 28505)

Since 2006, we have developed the useful and efficient technology on active coral reef restoration as the project of Japanese Fisheries Agency at Okinotorishima, the southernmost isolated island of Japan. Firstly, coral mass-culture technology by using sexual reproduction in aquarium was developed from 2006 to 2008 at Okinawa. As the result, the highest survival rate in one year later reached up to 80%. Besides, the mass-cultured juvenile corals grown on ceramic tiles were successfully transported from Okinawa to Okinotorishima, 1,100km away, via a research vessel taking 64 hours. On the other hand, we developed the artificial concrete block designed as a substrate for outplanting juvenile corals and installed them to the unsuitable area for coral such as sandy gravel bottom at Okinotorishima in 2009. Since 2010, field experiment has been carried out in which the transported ceramic tiles with juvenile corals were outplanted on the blocks. The highest survival rate of the coral in the artificial blocks in one year later marked more than 80% in an appropriate experimental condition. The next challenge is to expand restoration scale utilizing larval dispersal ability. Therefore, we are trying to develop of "the larval supply base", functioning as not only nursery for juvenile corals but also larval supply from maturity corals. It is estimated based on our basic test outcome that 100 square meters larval supply bases, stocking 9 mature colonies of the same species per square meter, have a potential for supplying 100 larvae per square meter on 40ha in Okinotorishima.

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DISSOLUTION OF CARBONATE SEDIMENT AT SEAGRASS MEADOW ESTIMATED BY TOTAL ALKALINITY FLUX AND PORE WATER PROFILES (Abstract ID: 28915 | Poster ID: 242)

Ocean acidification decreases the pH of seawater and the saturation state of minerals, and Eyre et al. (2014, Nature Climate Change) indicated that carbonate sediment dissolution could be more sensitive to ocean acidification than calcification by reef organisms. Particularly in seagrass-carbonate sediment, it has been suggested that both abundant labile organic matter and wide redox range would increase $pCO_2$ in sediment, and total alkalinity (TA) flux from sediment to water column caused by Mg-calcite dissolution would also increase. Here, we measured sedimentary dissolved oxygen (DO) and carbonate profiles in a seagrass area of Shiraho coral reef, Ishigaki Island, and TA flux at the sediment-water interface was estimated under natural hydrodynamic conditions using eddy covariance (EC). Almost half of the sediment was Mg-calcite derived from foraminifera and its Mg content was 16.4 mol%. Analysis of the sedimentary DO and Oxidation-Reduction Potential (ORP) profiles at night indicated that $O_2$ was depleted deeper than at least 4 mm and sulfate reduction could occur. While pore water TA and dissolved inorganic carbon values increased with depth, pore water saturation state of aragonite was constant at a value of ~ 2.3 during the entire nighttime. On the other hand, the calculated nighttime TA flux from sediment to water column was 0.9–3.2 mmol $m^{-2}$ $hr^{-1}$ though seawater in water column was oversaturated with respect to Mg-calcite. This would be caused by Mg-calcite dissolution and bacterial sulfate reduction.

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MARGINAL CORAL REEFS AND CORAL COMMUNITIES IN JAPAN (Abstract ID: 29388)

Japan covers a wide latitudinal range, stretching from subtropical to temperate areas. Coral communities and reef morphologies show significant changes along the latitudinal gradient, which provides baselines to understand coral reef development patterns and to examine the effect of climate change on coral communities. 1) Unique feature: The highest-latitude coral reefs in the world occur at Tsushima and Iki Islands (34˚N) (Yamano et al., 2012, Geology). These coral reefs are established under extremely low sea surface temperature (SST) and high turbidity setting. Thus defining the end of the distributional range, the reefs serve as baselines for understanding coral reef distribution along SST and turbidity gradients. 2) Historic change: A 80-year record of coral occurrence showed poleward range expansions of four species in response to SST warming (Yamano et al., 2011, GRL). A monitoring program revealed winter SST tolerance of each coral species, which enabled improved reconstruction of the past range expansions based on inter-annual variation of sea surface temperatures (Takao et al., 2015, Coral Reefs). 3) Future projection: It would require consideration of another important issue, ocean acidification. Without consideration of coral adaptation and/or acclimation, in the high CO2 emission scenario, coral habitats will be lost in the 2070s because of higher SST in the south and ocean acidification in the north, whereas the lowered CO2 emission scenario allows coral survive around the southern part of Japan even in the 2090s. This strongly suggests the importance of reducing CO2 emission for conservation of corals (Yara et al., in press).

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DAILY FLUORESCENT BAND RECORDED BEHIND BLACK BAND DISEASE (Abstract ID: 28107 | Poster ID: 155)

Coral diseases are growing concern for coral reef conservation as well as predation by starfish and bleaching due to warmer water. Black band disease (BBD) is a first coral disease found in Caribbean Sea and has been spreading many coral reefs worldwide. I found periodical green fluorescent bands as GFP on the surface of dead skeleton after BBD infection. These bands match daily pattern, and are observed exclusively on the light (or upper) side of BBD-affected corals. Fluorescent bands were obvious for encrusting, branching and foliacious *Montipora* corals those are most susceptible corals around Sesoko Island, Japan. Fluorescent bands are translucent, powdery, and some are spot-like form close to polyp structure. Peak band was observed at 535nm when excited at 410nm. Bands are stable in acidic/alkaline solution, in organic solvent, in sodium hypochlorite solution, and still have fluorescence more than a year for dried specimen. Progress rate of BBD was faster in upper (light) side during daytime. Bands are formed during daytime through some chemical changes affected by bacterial activities under the space of BBD.

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*ACROPORA TENUIS* LARVAE CAN EXPEL NON-ESSENTIAL*SYMBIODINIUM* STRAINS (Abstract ID: 28542 | Poster ID: 121)

*Acropora* corals must acquire *Symbiodinium* from the surrounding environment during early ontogeny. The genus *Symbiodinium* includes nine phylogenetically distinct groups (clades A-I), and each clade includes numerous types. Recent field observations revealed that naturally settled*Acropora* recruits typically harbor certain members of clades A and D, despite the presence of other *Symbiodinium* in the nearby environment. In contrast, *Acropora* larvae/juveniles can acquire a variety of *Symbiodinium* in the laboratory. Although this disparity between field and laboratory results might be attributed to *Symbiodinium* cell densities around the coral, it remains unclear how corals process accidentally acquired *Symbiodinium*within their tissue. Thus, we supplied *A. tenuis* larvae with three clade A strains (type A1 and type A3, which are often found within natural *Acropora*recruits, and type A2 relative, which is never detected within corals) and then determined the infection rate and density of infected cells within larvae. The infection rate and density of cells infected with types A1 and A3 did not decrease even after the supply of *Symbiodinium* cells was stopped. However, the infection rate and density of cells infected with the type A2 relative declined from 83.3 ± 20.8 to 46.7 ± 5.8% and from 8.2 ± 3.3 to 4.9 ± 0.9 cells/indiv., respectively, within 7 days after removal of *Symbiodinium*. Even in this case, cell division was observed within the larvae. These results suggest that *A. tenuis* can expel non-essential *Symbiodinium* strains.

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VARIATION OF KUROSHIO TRANSPORT DURING 1860-2007 AD INFERRED FROM CORAL NITROGEN ISOTOPE SIGNATURE (Abstract ID: 29259 | Poster ID: 97)

The Kuroshio Current supports the tropical reef corals thriving in the temperate areas along the Pacific coast of Japan. We reconstructed the variability of nitrate supply on Kuroshio front due to the current transport over the past 151 years using coral skeletal nitrogen isotopic composition (δ15Ncoral). A 151-year δ15Ncoral record is four times the length of the observational record (1971-present) of Kuroshio transport and could provide a direct comparison with global climate change, such as the Pacific Decadal Oscillation (PDO) index and El-Niño (ENSO), through recent global warming. Coral cores from Porites were collected from Tatsukushi Bay in 2008 on the Pacific coast of Japan, which is located on the northern front of the Kuroshio Current. δ15Ncoral was used as a proxy to record the δ15N of nitrate controlled by the upwelling of subtropical subsurface water, and δ15Ncoral was negatively correlated with observations of the Kuroshio transport (R=-0.69, P<0.001) and the 2-year lagged PDO index (R=-0.63, P<0.005) from 1972 to 2007. The 151-year record of δ15Ncoral suggested that the Kuroshio transport varied in ~25 year cycle, and the amplitude became more stable and the volume was intensified through the 20th century. The Kuroshio transport was intensified by the La Niña state in the early 1900s and by the El-Niño-PDO state after the 1920s. Our results suggested that the variation of Kuroshio transport is relevant to north pacific climate through the 151 years and controls nitrate supply on the Kuroshio front.

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THERMAL PERFORMANCE OF THE HIGH LATITUDE CORAL PORITES HERONENSIS: SIGNIFICANCE FOR ITS FUTURE DISTRIBUTION (Abstract ID: 28150 | Poster ID: 312)

A northward shift of hermatypic corals distribution due to the increase in seawater temperature under climate change has been observed in Japan, with further shift predicted in the future. The main factor limiting coral distribution is considered to be the lowest annual seawater temperature. Therefore, it is important to study the physiological response to temperature change of corals living in the vicinity of the northern distribution limit. The present study investigates the thermal performance of a marginal coral,*Porites heronensis*. The corals were incubated under different temperature for 14 days and their metabolims and physiological parameters were measured. The optimal temperature for the growth of the coral *P. heronensis*was showed to be around 21°C, higher than 19°C, the annual average SST observed in Nabeta bay. Critical lower temperature was 12°C with bleaching and high mortality. Bleaching was observed for all corals at 29°C. The results obtained showed that the annual lowest SST in Nabeta bay, 12°C, could limit the growth of *P. heronensis* with bleaching or even high mortality occurring during winter. Increased seawater temperature due to climate change could decrease bleaching occurrence and mortality during winter, resulting in an increase in the population of *P. heronensis* in Nabeta bay. It could also allow a poleward shift of the northern limit of its distribution. However, the annual maximum temperature in Nabeta Bay being 26°C, a future increase of more than 3°C could lead to possible bleaching during summer even in such high latitudes.

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SEASONAL VARIATIONS OF SEAWATER PCO2 AND SEA-AIR CO2 FLUXES IN A FRINGING CORAL REEF, NORTHERN SOUTH CHINA SEA (Abstract ID: 28112 | Poster ID: 370)

Evidence based on four field surveys conducted between July 2009 and April 2011 indicates that both sea surface partial pressures of CO2 (pCO2) and sea–air CO2 fluxes at Luhuitou fringing reef in Sanya, Hainan Island, northern South China Sea (SCS) are subject to significant seasonal variations. The diurnal variation of seawater pCO2 ranges from 264 to 579 μatm in summer, which is much larger than that in autumn (152-335 μatm), in winter (84-260 μatm), and in spring (114-228 μatm). The sea-air CO2 flux in summer (~9.6 mmol CO2 m-2 d-1) is also larger than that in other seasons (i.e. ~3 mmol CO2 m-2 d-1 in spring, ~3.5 mmol CO2 m-2 d-1 in autumn, and ~2.7 mmol CO2 m-2 d-1 in winter). The atmospheric pCO2 in this reef shows small diurnal and seasonal variations. The integration of the time-series pCO2 data shows that the reef area is a weak source of atmospheric CO2 at ~0.54 mol CO2 m-2 yr-1. Further analyses indicates that the seasonal variations of the surface seawater pCO2 in Luhuitou fringing reef are mainly affected by seasonally-dependent biological metabolic processes (organic process and inorganic process), and that the organic process play a more important role than the inorganic process. Seasonal sea surface temperature (SST) variations and hydrodynamic processes may also have some influence on seawater pCO2 variation.

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THE GROWTH AND CALCIFICATION OF THE CORALLINE ALGA, AMPHIROA SP. (Abstract ID: 30171 | Poster ID: 368)

The calcifying/coralline red algae play critical ecological roles including contributing significantly to primary productivity, enhancing critical structural strength and consolidating reef through calcification, as well as being key to a range of invertebrate settlement and metamorphosis processes in coral reef ecosystems. A new strain was isolated from the South China Sea and its characteristics was investigated. By analyzing structural features and 18s RNA, the strain was identified as Amphiroa sp. It contained biochemically precipitated calcium carbonate as skeletal material with high calcification rate. The growth rate with 3-4 g m-2 d-1 was determined. Additionally, the effects of pH on physiological performance of Amphiroa sp. was also investigated. The results revealed that growth rate was negatively impacted, while the calcification rate was rarely affected by ocean acidification.

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BACTERIAL AND EUKARYOTIC COMMUNITIES ASSOCIATED WITH*PALYTHOA TUBERCULOSA* – DIVERSITY AND RELATION TO PALYTOXIN DISTRIBUTION PATTERNS IN JAPAN (Abstract ID: 29177)

The function of coral-associated microorganisms have been broadly studied with relation to nutrient cycles, however, microbial diversity of other reef organisms and the roles of secondary metabolites are still scarce. *Palythoa tuberculosa* (Anthozoa: Zoantharia) is a common reef zoantharian, but lack of information on this species' microbial diversity. It also possesses a large non-peptide toxin, palytoxin (PTX). The origins of PTX and its analogs have not yet been identified, but dinoflagellates and/or bacteria are putative sources. We surveyed the diversity of the microbial communities of *P. tuberculosa* across different seasons to provide baseline information of community composition. In addition, we measured PTX concentrations to investigate correlations between microbial communities and PTX. We sampled four times from Kabira and Teniya, Okinawa, Japan. PTX content was checked in colony tissue. DNA was isolated from gastric cavity water and used for next-generation amplicon sequencing of 16S ribosomal DNA. Preliminary results showed the dominant bacteria was family Endozoicimonaceae at both locations. At Teniya, 35% to 96% of *P. tuberculosahad* PTX while at Kabira only up to 40% of the colonies had PTX. Analyses of the correlation between bacterial communities and PTX levels are still in progress.

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ENDOLITHIC BACTERIAL COMMUNITIES AND POTENTIAL FUNCTIONS IN THE CORAL *ISOPORA PALIFERA* (Abstract ID: 29209)

Microbial endoliths, which inhabit interior pores of rocks, skeletons and coral, are ubiquitous in terrestrial and marine environments. Usually, there was a distinct green-pigmented layer within the skeleton of the coral *Isopora palifera*. To characterize diversity of endolithic bacteria, 16S rDNA amplicon pyrosequencing was used to investigate bacterial communities in the green layer of eight *I. palifera* colonies retrieved from two locations and different depths on Green Island, Taiwan. The dominant bacterial group in the green layer belonged to the phylum Chlorobi, green sulphur bacteria being capable of anoxygenic photosynthesis and nitrogen fixation. Specifically,*Prosthecochloris* were prevalent in this green layer. Furthermore, to describe the potential function of

endoliths along different depths, nine metagenomes of endolithic microbes in coral were characterized by whole-genome shotgun sequencing approaches. Results showed that functional traits in coral skeleton along depths were more conserved than bacterial taxa, which indicated potential functional redundancy of endoliths. This is the first study to provide a detailed taxonomic and functional profile of endolithic bacteria in coral, and to determine prevalence of *Prosthecochloris*in the green layer. Finally, we infer that 1) these bacteria may have an important functional role in the coral holobiont in the nutrient-limited coral reef ecosystem; 2) a core functional trait of endoliths in coral shows limited variation in response to environmental heterogeneity.

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DISTRIBUTION AND PATTERNS OF POPULATION OUTBREAK OF CROWN-OF-THORNS STARFISH IN JAPAN OVER 100 YEARS IN ASSOCIATION WITH GLOBAL WARMING AND LARVAL DISPERSAL (Abstract ID: 28575)

Population outbreak of the Crown-of-Thorns Starfish (COTS), Acanthaster planci, has been the major threat to the reef ecosystem in the Indo-Pacific region though their cause(s) are still unclear. Here, we reviewed the previous records of COTS outbreaks and occurrence in the Japanese waters over 100 years (1912-2015). Overall, COTS distribution has been extending northwards from the previously northernmost site Amami Ohshima since 1953. Global warming seems to be partly responsible for the increase in the frequency and intensity of population outbreaks in the temperate waters. Genetic homogeneity within Japanese COTS populations indicates that larval dispersal is likely causing northward migration. The patterns of the two major population outbreaks in the 1970s and 2000s were complex but had similar patterns. The western Okinawa main island populations had the highest probability of being the source for secondary outbreaks within Japan. Amami population is also likely to be an important source for outbreaks of the temperate waters. On the other hand, population outbreaks have never been observed at least three regions; Ogasawara, Tokara and Ohsumi Islands. Ogasawara is located approx. 1000km south of the Kuroshio Current so that infestation via larval dispersal from other populations might hardly occur. The latter two regions are, however, located in the middle of Kuroshio Current, implying that there are some key environmental factors that suppress recruitment and/or juvenile survival.

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MECHANISM OF ESTABLISHMENT AND MAINTENANCE OF*GONIOPORA STOKESI* POPULATION AROUND OKINAWA, JAPAN (Abstract ID: 28637 | Poster ID: 180)

*Goniopora stokesi* is widely distributed in tropical and subtropical regions throughout the world. This species is commonly found free-living on soft substrates and makes dense populations in isolated environment, probably due to its characteristic manner of asexual reproduction: daughter colonies are formed on the surface of the parent colony and later detach from the parental colony. In 2010, the largest *G. stokesi* population ever reported was found at 30 m depth in Oura Bay in Okinawa Island. This study investigated the population dynamics, its genetic population structure, reproductive strategy and the growth rate of colonies to understand the mechanism of establishment and maintenance of the *G. stokesi* population in Oura Bay. The colony densities in the studied quadrats did not increase, while daughter colonies were produced year round. On the other hand, this species was gonochoric and spawned gametes in late August to early September in Okinawa Island. An analysis of the ITS region of rDNA indicated that the colonies sampled from this population were not clonemates but exhibited no gene flow from another population in Okinawa. These results suggested that this population was maintained via not only asexual reproduction but also sexual one within the population. The growth rates of daughter colonies were similar to those reported for other poritidae species, while the colony size at sexual maturity was smaller than others. These reproductive traits of this species may be effective in establishing and maintaining its population in unstable environment.

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REGIONAL-SCALE EROSION OF MODERN CORAL REEF ECOSYSTEMS (Abstract ID: 28778)

Coral reefs serve as natural barriers that protect adjacent shorelines from coastal hazards such as storms, waves and erosion. Projections indicate global degradation of coral reefs due to anthropogenic impacts and climate change will cause a transition to net erosion by mid-century. No studies have quantified the amount of regional-scale accretion or erosion that has occurred since the industrial revolution. Here, we calculate the spatial gains and losses of seafloor elevation and volume for 5 coral reef ecosystems in the Atlantic, Pacific and Caribbean over the last several decades. We show that these reef systems have already transitioned to a net-erosional state. Our most conservative estimates indicate mean seafloor elevation change at these 5 sites ranges from -0.06 to -0.8 m, corresponding to net volume losses ranging from 0.2 Mm3 to 52.8 Mm3 (million cubic meters). Regional-scale loss of seafloor elevation and volume has accelerated the rate of relative sea level rise, and increased current water depths of coral reef ecosystems to levels not expected until near the year 2100. The magnitude of erosion that has already occurred, trajectories for continued coral reef degradation and increasing sea level place these ecosystems and nearby communities at elevated and accelerating risk to coastal hazards. Our results set a new baseline for projecting future impacts to coastal communities resulting from erosion of coral reef systems and associated losses of natural and socio-economic resources.

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¬CONSERVING SMALL-SCALE FISHERIES UNDER UNCERTAINTY IN SELF-RECRUITMENT USING SIZE LIMITS (Abstract ID: 29976)

A major challenge in managing for conservation and fishery sustainability at small spatial scales is the unknown amount of external versus self-recruitment, and the applicability of fishery management tools under such conditions. We tested the application of minimum size limits by using empirical data we gathered to create a mixed-recruitment, size-structured integral projection model and simulated harvest to determine the size limit resulting in both increased population abundance and maximum annual harvest for self-recruitment amounts ranging from 0-100% of total recruitment. Over a wide range of life histories, a single 'robust' size limit resulted in increased population abundance and therefore sustainable harvest within 10% of the maximum harvest for every possible recruitment mix. In addition to allowing individuals to reproduce before being harvested, minimum size limits can also be used to rebuild population abundance and maximize sustained fishery harvest when managers have no knowledge about recruitment sources.

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EFFORTS OF SMALL-SCALE FISHERS IN CORAL REEF CONSERVATION: CASE ILLUSTRATIONS FROM THAILAND (Abstract ID: 28621)

Coral reefs and small-scale fisheries are closely linked; healthy coral reefs not only provide abundant fishery resources for small-scale fisheries, but also an additional source income for fishers who operate recreational tourism. Maintaining coral reef health could be an important concern to ensure sustainability of their livelihoods. In this study, semi-structured surveys and focus group meetings were conducted to understand the perception of small-scale fishers on importance of coral reefs and their efforts on coral reefs conservation in Ko Samui and Ko Chang, the famous tourism destinations located in the western and the eastern Gulf of Thailand. Although the islands have been influenced with tourism development, small-scale fisheries are still existent. Most of the fishers realized that coral reefs are important for sustaining their livelihoods as their primary sources of food production. Besides, during tourism season, they also gain benefits from tourism-related activities such as providing boats for tourists to diving or fishing sites. They all agreed that coral reefs should be conserved and sustainably utilized. Consequently, many environmental conservation activities have been initiated by local communities attempting to protect coral reefs such as reef cleanup activities, coral reef monitoring volunteers etc. This study could illustrate perception and some efforts of small-scale fishers that enhance abundance of fishery resources and coral reef ecosystem balance.
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A TURNAROUND AT SANYA NATIONAL CORAL REEF NATURE RESERVE? (Abstract ID: 28163 | Poster ID: 703)

Located in the South China Sea, Sanya, Hainan province, is China's only seaside tropic resort city where 13 million tourists visited annually. While Sanya's GDP rose by tenfold over a decade, such unprecedented growth also brought pollution, habitat destruction

and other stresses that overwhelm its coral reefs. Since 1980s, researchers noted a plummet of coral coverage from 80 to 12%, with significant declines in distribution and diversity as well. While the central government tried to control such damages through legislation, its ability to influence policy implementation was limited. At the local level, performance of city and provincial government officials was measured by GDP growth and their ability to meet job and tax revenue targets. Hence, enforcement of protection laws was not a priority, even in marine reserves. Recently, however, research and monitoring have gained traction, media reports become less censored, and government priorities have shifted to include environmental protection. Public awareness has increased, and the authorities seem to recognize that conservation is not just good governance, but also good business practice. Summarized here are China's recent efforts in managing the Sanya National Coral Reef Nature Reserve, its only national-level MPA dedicated to coral reef conservation. Through literature research and interviews, we examine the roles played by scientists, journalists and government officials, and how science informs policy making and management. A turnaround is perhaps underway due to renewed prioritization from the central government.

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CURRENT STATE AND FUTURE PROSPECTS OF CORAL REEF FISHERIES IN THE SOUTH CHINA SEA (Abstract ID: 28091)

We investigate future economic and ecological trajectories of reef fisheries in the South China Sea (SCS) under combined management and climate change scenarios. We first integrate existing data to assess the current social, economic, and ecological status of SCS reef fisheries. Secondly, we use an ecosystem model to investigate how scenarios of fisheries management and climate change will affect reef fish catch and biomass in the future ( 2045). SCS artisanal and subsistence reef catch was approximately 1.1 million t in 2010, supporting the livelihoods of up to an estimated 3.2 million reef fishers, and providing food for up to approximately 32 million people. Under a scenario of low greenhouse gas emissions and sustainable fisheries management, reef fisheries catch was projected to increase by 20% by 2045 relative to 2015, and by 40% under a status quo management scenario (no new fishing restrictions) and high emissions. The projected number of reef fishers across SCS countries in 2045 can potentially catch 35% and 16% more per fisher under a status quo and sustainable management scenario, respectively. However, the increased catch under a status quo scenario comes at the expense of a large loss in top predators from the reef. Based on these projections, we will analyze the social and economic implications on reef fisheries dependent communities. By assessing the ecological and societal trade-offs associated with potential futures, this study helps to identify what alternative policy pathways SCS countries can take now to progress towards socio-ecologically resilient coral reef fisheries in the long-term.

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GENOME-WIDE DNA METHYLATION PROFILING REVEALED COMPLEX ROLES IN ACROPORA MILLEPORA (Abstract ID: 28995)

Eukaryotic cytosine methylation is an ancient trait present in both animals and plants. However, knowledge about DNA methylation in corals is still in its infancy. We show that the coral Acropora millepora has a typical animal gene methylation machinery. We performed bisulphite sequencing and found that DNA methylation only occur at CpG dinucleotides. CpG methylation exhibits similar patterns as in other animals and plants, such as cluster of methylated cytosines and symmetric methylation from both strands, but variations among features were also evident. We confirm the preference of DNA methylation in ubiquitously expressed genes, but also observed complete promoter methylation from a subset of inactive genes that indicates a repressive role on gene expression. In spite of the higher mutability of methylated sites, a comparison of orthologous genes in A. millepora and Acropora digitifera, showed that CpG containing codons were overrepresented at the first codon position (CGN codon) suggesting strong purifying selection. Finally, we compared DNA methylation profile with two other cnidarian species, namely Hydra magnipapillata and Nemetostella vectensis. On average, A. millepora has a higher methylation level than N. vectensis, but less than H. magnipapillata. A distinctive feature of the Hydra methylome is that introns are highly methylated, probably due to their high transposon content, while transposons outside of introns are less methylated. Our results support multiple functions of DNA methylation in coral genomes, which will lead to a deeper understanding of the complex relationships among DNA methylation, transcription plasticity and transposon silencing.

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ASSESSING MPA EFFECTIVENESS USING ECOLOGICAL, SOCIAL AND ECONOMIC INDICATORS IN PHILIPPINE COMMUNITIES (Abstract ID: 29220)

The establishment of MPAs in the Philippines has proliferated and has been shown to allow for the recovery of declining coral reef conditions. While this growth of MPAs can be an indication of potential benefits, other studies have showed that many MPAs in the country are not so effective. These concerns highlight the need to better understand processes and standards that go into establishing MPAs, if and how these lead to social and ecological benefits for the community and the MPA, and potential feedbacks. This study used a socio-economic assessment tool (SEAT) and an MPA Effectiveness Assessment Tool (MEAT) to look at the interplay between investments, processes and benefits for various MPA sites. MEAT gauges governance levels in the study sites, while SEAT incorporates resource valuation considerations and livelihood parameters to evaluate benefits derived from effective management. General Additive Mixed Models were used to gauge associations between inputs and outputs from MPA development activities. Investments into MPA establishment were correlated to enhanced productivity of reefs (e.g., increased diversity, and catch of reef-associated organisms). A relatively strong indicator that the MPA translates to increased incomes and employment appears to be the level of revenues garnered by the MPA itself followed by the condition of the management plan. Interestingly, these relationships are non-linear, potentially reflecting the complex political aspects underlying the system. The relations and thresholds between ecological-socio-economic indicators are further explored
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CORAL DISTRIBUTION MAPPING OF OKINOTORISHIMA USING TIME-SERIES HIGH RESOLUTION SATELLITE IMAGERY. (Abstract ID: 28544 | Poster ID: 536)

This study was aimed to understand recent coral distribution and their secular changes at Okinotorishima, Tokyo, JAPAN, by utilizing high resolution satellite imagery. Imaginary taken in 2006, 2011, and 2012 were used in this study. For the analytical method of the imagery from 2006, a coral coverage distribution map was made, after clustering using satellite imagery, by superimposing each cluster on existing coverage distribution map made around the same time. For imagery from the rest of the years, the coverage was given automatically according to the relationship between data of each cluster and its coral coverage based on the analysis of 2006. The accuracy of the analysis was verified in comparison with the result of the field survey. It was revealed that the accuracy of the coral coverage was within around ±4~5% from the analyzed value and the one of the coverage change was within around ±5%.

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OBSERVING CHANGES IN CARBONATE CHEMISTRY ON CORAL REEFS ACROSS THE PACIFIC (Abstract ID: 28837 | Poster ID: 376)

Many coral reef scientists are researching how ocean acidification is changing seawater chemistry and affecting coral reef ecology. Most research is conducted at limited spatial and temporal scales. In 2005, the Coral Reef Ecosystem Program (CREP) began analyzing seawater samples for dissolved inorganic carbon and total alkalinity to assess changing carbonate chemistry across the Pacific. Since 2013, in concert with an additional suite of oceanographic instrumentation, these two analytes have continued to be collected by CREP at 49 coral reef sites as part of NOAA's National Coral Reef Monitoring Program. CREP's ocean acidification measurements span a spectrum of spatial and temporal scales at islands and atolls ranging from 28 N to 14 S. We will present long-term nearshore, near-reef, and 1 km offshore water chemistry data to reveal differences between islands and elucidate the importance of oceanographic processes (e.g. Equatorial Undercurrent and El Nino Southern Oscillation) on reef chemistry.

Additionally, we will present diurnal water sample data, supported with high-resolution instrument records for reefs in the central, equatorial, and South Pacific. Both of these sampling efforts (e.g. onshore-offshore references and diurnal sampling) enable CREP to calculate reef-level net ecosystem calcification (NEC) and net ecosystem production (NEP) rates. These rates are variable across the Pacific, serve as useful indicators of coral reef ecosystem health, and establish novel datasets for the islands and atolls CREP monitors.

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KAI KULEANA KAKOU - UNITING TO CARE FOR WEST HAWAII'S COASTAL AND MARINE COMMUNITIES (Abstract ID: 29912 | Poster ID: 687)

With public and private funding support, eight coastal communities in West Hawai'i met in 2012 to identify shared challenges and opportunities and agreed that mutual support would be of benefit. Since that time, they have grown into the Kai Kuleana Network and are devoted to supporting one another in stewardship, education, and policy initiatives in various stages of development and implementation. Through quarterly participatory meetings, shared values and training objectives have been identified and substantive progress has been made in accomplishing both individual community objectives and broader goals that affect all of West Hawai'i. By sharing knowledge and lessons learned with one another and at larger events, such as the Hawai'i Conservation Conference, network members inspire others, maintain effective communications, accelerate learning and amplify impact to address complex problems faced by coastal and marine communities in West Hawaii – problems that are shared throughout Hawai'i and the Pacific.

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RECREATIONAL SPEARFISHING ON CORAL REEFS: AN AUSTRALIAN PERSPECTIVE (Abstract ID: 27785)

Recreational fishing is a growing component of the world's fisheries and is increasingly linked to declines in fish populations. However, due to an absence of past monitoring data, recreational fisheries are poorly understood, difficult to assess and pose governance challenges. We explored historical trends in recreational spearfishing in Australia, as documented in a 58-year chronology of spearfishing magazines. Data were extracted from reported fish captures, advertising, and spearfisher commentary and assessed with regression models and ordination analyses. The proportion of coastal fish captures reported declined by approximately 80%, whereas coral reef and pelagic fish reports increased 1750% and 560%, respectively. Reported catch composition shifted markedly from coastal temperate fishes during the 1950s to 1970s to coral reef and pelagic species in the 1990s to 2000s. The mean weight of reported trophy coral reef fishes also declined significantly over the study period, potentially reflecting their vulnerability to fishing. Interviews with fishers in Australia and the Solomon Islands also provided cross-cultural insight into the reasons why fishers engage in fishing. We found a strong perception that fishing delivers a range of benefits to individuals and societies. These results emphasise the need for regulatory agencies to work closely with fishing communities to observe fisher behaviour, detect shifts in target species or fishing intensity, and to channel the motivations and values of fishers for the benefit of ecosystems and society.

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A SEMI-IN SITU EXPERIMENT OF LARVAL DEVELOPMENT OF SCLERACTINIAN CORAL ACROPORA GEMMIFERA IN RESPONSE TO ELEVATED PCO2 (Abstract ID: 29232 | Poster ID: 25)

Here, we investigated the effects of acute exposure to elevated CO2 on skeletogenesis and gene expression in primary polyps of Acropora gemmifera and the variance of metamorphosis using Illumina RNAseq approach. Embryo and juvenile were exposed to 3 targeted pH values (pHT = 8.13, 7.82, and 7.53), which correspond to the designated pCO2 levels (389, 700, and 1214 μatm) that were projected for the pCO2 levels of the present, the end of the present century, and next century. According to the data of skeleton development, compare the proportion of 4-loop-synapticulae period at 6d-28d between groups, there were significant differences ($P<0.05$) between groups pH8.1 and pH7.5 at 11d-28d, pH8.1 and pH7.8 at 15d-21d, and pH7.8 and pH7.5 at 15d-28d. The reference transcriptome consisted of 64556 contigs with mean size of 914 bases and N50 of 1612 bases. We have found 50097 total genes, and 2529 were identified on the basis of sequence similarity to known genes were expressed in A. gemmifera. The gene ontology analysis indicated that the transcription of genes associated with the terms of biological process, cellular component and molecular function. According to the analysis using the Kyoto Encyclopedia of Genes and Genomics (KEGG) database, we identified 22 important genes which were involved in major Organismal Systems, such as mineral absorption, endocrine and other factor regulated calcium reabsorption, vasopressin regulated water reabsorption, proximal tubule bicarbonate reclamation, osteoclast differentiation, gastric acid secretion, etc.

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VERTICAL PROFILES OF CALCIUM AND PH IN THE CORAL GASTRIC CAVITY: IMPLICATIONS FOR OCEAN ACIDIFICATION (Abstract ID: 28522)

One hypothesis to explain reductions in coral calcification rates caused by ocean acidification is that elevated seawater CO2 results in increased transport of CO2 into the calcifying fluid, acidifying the fluid and reducing calcification. A major route through which CO2 may enter the calcifying fluid is through the coelenteron or gastric cavity. It is therefore important to understand the processes controlling coelenteron pH, which may partially affect the response of corals to ocean acidification. In this study, pH and Ca2+ microsensors were combined with a reaction-diffusion model to study the dynamics of pH and Ca2+ in the coelenteron of the reef corals Turbinaria reniformis and Acropora millepora. Our study showed that Ca2+ concentrations linearly decreased from the mouth to the base of coelenteron due to calcification. Based on these profiles, instantaneous calcification rates could be estimated, but lower than the rates derived by buoyant weight measurements. In contrast, the H+ concentration remained relatively constant over much of the coelenteron cavity before it increased sharply towards the base of the coelenteron, indicative of proton-pumping from the calcification fluid below. The resulting H+ gradient between the coelenteron cavity and the calcification site was >10 times higher than previously predicted. Consequently, the energy required to export protons from the calcifying fluid was estimated to be ~3 times higher than previously calculated. Our numerical simulation reveals that ocean acidification (OA) decreases the pH at the base of coelenteron, and this pH decline is greatly amplified by the deeper coelenteron and high calcification rates.

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PRELIMINARY RESULTS OF WHOLE GENOME SEQUENCING ANALYSIS OF *ACANTHASTER PLANCI* IN JAPAN, HAWAII AND THAILAND. (Abstract ID: 28570 | Poster ID: 73)

Sea level fluctuations associated with Pleistocene glaciation have great genetic impacts on marine species that seldom experience vicariance. Previous studies using morphological data and partial mitochondrial genes indicated Pleistocene vicariance caused allopatric speciation between the Indian and Pacific Oceans in marine species. However, impacts on the whole genome are still unclear. Here we present preliminary results of whole genome comparisons of *Acanthaster planci*, whose sudden population outbreaks have been one of the largest issues in conservation of coral reefs in the Indo-Pacific region, to examine the impacts of Pleistocene vicariance at a whole genome level. We collected specimens from Phuket in Thailand (Indian Ocean species), Miyazaki in Japan (Pacific species) and Hawaii (genetically distinct Pacific species). Heterozygosity was highest in Miyazaki and followed by Phuket and Hawaii, implying the isolated population in Hawaii has lower genetic diversity. Estimated whole genome sizes ranged from 400 to 450 Mbp. While the similarity of the whole mitochondrial genome sequence was about 91% between Indian and Pacific species that between two Pacific species was 99%. On the other hand, a rough estimate of whole genome sequence similarity between Indian and Pacific species was 98% and that between Miyazaki and Hawaii was 99%. These results suggest, as predicted by smaller effective population size of the mitochondrial genome, neutral mitochondrial genes had experienced much stronger genetic drift than nuclear genes.

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TEMPERATURE VARIATION AND CORAL COMMUNITY STRUCTURE OF MESOPHOTIC REEF ECOSYSTEM IN PALAU (Abstract ID: 28514)

Tropical mesophotic reef ecosystems are receiving attention in recent years among coral reef researchers due to their potential as refugia for shallow coral reef ecosystems. Light has been shown to be a limiting factor of coral community in mesophotic reefs while temperature was suggested as not a significant abiotic factor. In light of the prediction of severe El Nino event for 2015/16, seawater temperature variation and its effects on coral community in mesophotic reefs can fill the critical gap in knowledge in the physical-biological link between mesophotic reefs and their shallow counterparts. An ongoing seawater temperature monitoring in several mesophotic reef ecosystems in Palau has been carried out since year 2014. Temperature loggers are being deployed at every 5-m depth interval up to 40 m depth in the outer reefs in Palau. Temperatures as low as 19 to 22 degree Celsius have been recorded in depths between 30 to 40 meters with daily fluctuation ranged from 8 to 10 degree Celsius. Extent of cool water pulsing was recorded as shallow as 15 m depth. Seasonal upwelling occurred at higher frequency between January to June resulted in bigger daily and monthly temperature fluctuations in deep water compared to other months. This indicates that corals in mesophotic reefs in Palau are constantly being subjected to big temperature variations. Additional information such as reef community, hydrodynamic processes, light availability, nutrient flux is needed to provide comprehensive baseline data of mesophotic reefs in Palau.

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IDENTIFY TYPE AND DISTRIBUTION OF REEF SHARKS SPECIES IN MEKO WATER, DISTRICT OF EAST FLORES, EAST NUSA TENGGARA (Abstract ID: 29480 | Poster ID: 273)

Adonara Island is one of big islands in District of East Flores that has total an approximately 519.64 km2 of land area. Based on shark bycatch survey in January 2015 by WWF Indonesia, it is known that 71.31% of shark species is caught accidentally. Meko Water is the highest area for shark bycatch level than other areas. The purpose of this research was to collect data and information about types, distribution and habitat of shark species in Meko Water, East Flores. We conducted underwater visual census with long swim in for 4 different depths (5, 10, 15 and 20 m) for 40 minutes (10 minutes in each depth). Location determination was based on multilevel methods with total of 20 dive sites that were divided into 3 different clusters (semi hotspot, hotspot and control zone). There were 2 species of sharks that were found in Meko Water; blacktip reef sharks (Carcharinus melanopterus) with 86 sightings (82.69%) and whitetip reef sharks (Triaenodon obesus) with 18 sightings (17.31%). The average size of blacktip was 100 cm with range of 50-150 cm and whitetip was 103 cm with range of 70-120 cm. The highest sighting of sharks was found in fringing reef (75%) in control zone as many as 39 sightings. The result of this research will used to be a basic information for formulate the recommendation for shark fisheries management in East Flores District. Keywords: shark species, distribution, sightings, Meko Water, East Flores

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EFFECTIVENESS AND PRODUCTIVITY HAND LINES WITH DIFFERENT BRANCH LINE AROUND PORTABLE FISH AGGREGATING DEVICE (Abstract ID: 27871 | Poster ID: 264)

This research used portable FADs, hand line with a length of branch line to be 0.9 m; 1.2 m; and 1.5 m. The purpose of this research to prove influenced of the length of branch line on technical performance. This research was used experimental fishing methods in around of portable FADs area. The fishing location at Indian Ocean on 8°07.615' S - 106°24.89' E and 8°21.03' S - 106°26.89' E for 6 days and grouped period into morning and afternoon. The catch was 176 fishes with weight 379.7 kg, they were 104 yellowfin tuna (254.7 kg), 68 skipjack tuna (116.1 kg ) and 4 dolphinfish (8.9 kg). Hand line with branch line 1.5 m produced at most yellowfin tuna, as many as 70 fishes with weight 141.3 kg, or an average individual weight of 2.83 kg. The result of the analisys of varians F-test was p-value = 0.397 > 0.05; it means there is no influence significantly the length of branch line catches obtained. Key words: FADs portable, hand line, branch line, Indian Ocean

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RAPID ASSESSMENT FOR CORAL DISEASE IN SAWU SEA MARINE NATIONAL PARK, INDONESIA (Abstract ID: 29464 | Poster ID: 165)

In November 2014, The Nature Conservancy coordinated a Rapid Ecological Assessment of the Sawu Sea Marine National Park (SSMNP) that included measures of reef health. Health indicators included disease, bleaching, predation, overgrowth. Of 54 surveyed reefs, 52% were badly damaged, 40% in fair condition, and 8% were healthy. We recorded 2,068 scleractinian coral colonies with health problems: 45% suffered predation and lesions caused mainly by bioeroders and fishes, 31% overgrowth by invertebrates (mainly sponges) and algae, 17% stages of bleaching, and 7% disease dominated by white syndromes. Coral diseases included Skeletal Eroding Band, Brown Band, Black Band, Yellow Band, White Syndrome, and Growth Anomalies. Porites, Acropora, Montipora, and Stylophora experienced highest frequencies of disease. Favia and Platygyra, important reef framework corals, were among the top ten most diseased corals. Owing to the significance of corals as indicators for the state of the marine environment, this coral diseases information is crucial for management of coral reef conservation areas within the SSMNP.
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DYNAMIC CHANGES IN GENE EXPRESSION DURING EARLY STAGE OF CORAL-ALGAL SYMBIOSIS (Abstract ID: 29403 | Poster ID: 124)

Acroporid juvenile corals contain the different Symbiodinium clade (e.g. clade A , clade D) from adult colonies which contain clade C. Previous study has shown that clade C Symbiodinium hardly increased in juvenile polyps during the first 2 months after inoculation, while clade D spread in polyps in about two weeks. It was unclear why these Symbiodinium increased in juvenile polyps in different timings. It seemed that host corals have different preparation periods to make endosymbiotic relationship with clade C and clade D. In this study, we focus on the early symbiosis stage between coral and two Symbiodinium (clade C and clade D), and investigated molecular mechanisms for the establishment of coral-Symbiodinium endosymbiosis with transcriptome changes by RNA-sequencing (RNA-seq). The result showed that the number of differentially expressed genes (DEG) was increased with increasing of endosymbiotic algae. From this result, we found some enriched biological processes in endosymbiotic juveniles. We present here about candidate genes involving in establishment of endosymbiosis, and the differences in clade C-symbiosis and clade D-symbiosis.

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PREDICTED RESPONSES OF CORAL REEFS TO THERMAL STRESS AND ITS APPLICATION TO CORAL REEF MANAGEMENT (Abstract ID: 29199)

Vulnerability of thermal stress to coral reefs such as mass coral bleaching and threaten reefs worldwide. NOAA Coral Reef Temperature Anomaly Database Version 4 (CoRTAD) with weekly data of 4 x 4 km resolution from 1981 was used to develop a tool for assessing bleaching risk assessment for the entire atolls of Maldives. Application of outputs of this tool enabled identifying reef areas that have the highest and lowest risk to bleaching. This study use thermal stress information at selected reefs in Baa atoll Biosphere reserve and assess the reefs using bleaching assessment methodology prepared by Australian Institute of Marine Sciences as standard means of assessing bleaching. This is particularly useful in time of predicted bleaching and compare with proxies of chronic and acute thermal stress. Identification and application of these (acute and chronic) thermal stress areas enabled to put evidence to the theory: corals acclimated to warmer conditions fare better during acute (bleaching) events than corals acclimated to cooler conditions. Policy makers and reef managers can use the outputs of this through identification of reef areas that are resilient and vulnerable to coral bleaching for developing reef management policy and strategy. It can also be used as an advocacy tool for climate change impacts on coral reefs of Maldives and consequential economic impacts.

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CHARACTERIZATION OF AMMONIUM TRANSPORTERS IN*SYMBIODINIUM MICROADRIATICUM* (Abstract ID: 29068)

Nitrogen is a limiting factor for growth in oligotrophic environments of tropical seas. Accordingly, many marine organisms acquired the ability to fix nitrogen from inorganic sources. Corals, as well as *Symbiodinium*, their dinoflagellate symbionts, are able to utilize ammonium as an inorganic nitrogen source. In a recent study of *Symbiodinium* genomes, we revealed an unexpected abundance and diversity of ammonium transporter (AMT) genes across this genus. Phylogenetic analysis of those genes indicated homology to yeast and bacterial ammonium transporters; protein sequence analysis of cloned cDNAs verified the conservation of residues essential for AMT function. These findings suggest that *Symbiodinium* might have evolved an excess of AMTs in response to nitrogen limitation *in hospite*.*Symbiodinium* reside within a specialized intracellular organelle, termed symbiosome, which provides an acidic microenvironment with a pH of 4-6, as opposed to a pH of 8.1 typical of seawater. In order to determine if AMTs evolved in response to symbiosis, we aim to perform functional analysis of these transporters in yeast mutants to determine their specificity, affinity, and

pH-dependent activity. We also expect to see an increase in *Symbiodinium* growth rates as a response to controlled culture experiments using decreased pH and limited ammonium concentration. We believe that the evolution of functional AMTs at different pH conditions is a key aspect in maintaining a symbiotic lifestyle.

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THE IMPACT OF HEAVY METALS CONTENT TO GROWTH OF CORALS PORITES LUTEA BASED ON ANNUALLY-BANDED AT TUNDA ISLAND, BANTEN BAY (Abstract ID: 29208 | Poster ID: 390)

In order to assess pollutants and the impacts of environmental change at Tunda Island, heavy metal concentrations of Cr, Sr, Fe, Zn, and Pb were traced through analysis of coral skeletal growth bands in cores of the massive coral Porites lutea. Core sections were examined using x radioagraphy and samples extracted from annual growth bands. Samples of coral skeleton were analyzed using neutron activation analysis and atomic absorption spectrometry to detect metal concentrational in annual growth bands. Results indicated that corals on the windward side of the island incorporated metal concentrations (Cr, Sr, Fe, Zn, Pb) in 1940 and metal levels were still detectable up to 2014. On the leeward side of the islands accumulation of heavy metals in the coral skeleton began in 1969 and was still evident up to 2014. The concentration of heavy metal pollutant in corals from the windward and leeward reefs showed a significant decline over time, while the concentration of strontium remained relatively stable. Anthropogenic influences on the Java mainland are likely responsible for heavy metal pollution in seawaters around the island. Results from this study show that the coral P. lutea accumulates heavy metals in its skeleton and this ability makes it a useful proxy for monitoring and recording environmental pollution at the study site. Keywords: heavy metals, P. lutea, annually growth bands, Tunda Island

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BLEACHING IN PALAEOZOIC CORALS? (Abstract ID: 27867 | Poster ID: 235)

Recent scleractinian corals owe their bioconstructing abilities to symbiosis with dinoflagellates. These algae do not fossilize, hence the reasoning for the photosymbiosis is indirect. In scleractinians photosymbiosis usually correlates with high integration of large sized colonies and small sizes of polyps. The oldest known presumably photosymbiotic scleractinians are Triassic (~245 Myr). Earlier Palaeozoic reefs were built by other corals: Tabulata and Rugosa (subclasses extinct at the end of Permian, ~252 Myr). Palaeozoic bioconstructions containing corals first appeared in the Ordovician (~450 Myr). It has been evidenced that tabulate corals posessed photosymbionts as early as in the Silurian (~430 Myr), but Ordovician specimens from Estonia suggest even earlier photosymbiosis. Reefal structures were several times in severe decline during their history. It has been hypothesized that the cause of these events were expulsions of zooxanthellae (possibly similar to bleaching). The aim of this study is to test this hypothesis. One of such collapses of reefal systems was the Late Devonian (~375 Myr) extinction event. Tabulate faunas from the Late Devonian of the Holy Cross Mts (Central Poland) are investigated here. The analyzed pre-extinction faunas have moderately integrated colonies, with small individuals and moderately large colonies, suggesting photosymbiosis. Post extinction corals have larger individuals, small colonies, and variable integration levels, being possibly aposymbiotic. These observations may evidence change in photosymbionts, similar to recent bleaching.

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EARLY-MIOCENE REEFS IN THE SIAMANÁ FORMATION, LA GUAJIRA – NE COLOMBIA (Abstract ID: 29726 | Poster ID: 6)

We studied two reef sites (Arroyo Ekieps and Arroyo Uitpa) in the Siamaná Formation in the Guajira Peninsula, Northern Colombia. Our preliminary results indicate that: i) The reefs are composed by 28 species of zooxanthellate corals, included in 16 genera and 12 families commonly associated to shallow environments and to patch and fringing reefs. There are four species of Montastraea and Porites, three species of Astrocoenia, two species each of Agathiphyllia, Diploastrea, Siderastrea, one species each of Acropora, Alveopora, Antiguastrea, Astreopora, Colpophyllia, Goniastrea, Goniopora, Heliopora, Millepora, Stylophora and one specimen of the Caryophylliidae family. Arroyo Ekieps has a higher richness (25 species) than Arroyo Uitpa (9 species). ii) There were low levels of siliciclastic input in Arroyo Uitpa and no significant input in Arroyo Ekieps. iii) The presence of larger archaiasinids , Miogypsina sp. and Amphistegina ssp. suggest an early Miocene age for both sites. iv) Raup-Crick Similarity Index shows a high similarity to early-Miocene reefs in Mexico, Florida and Venezuela. Further research effort will be focused on dating more precisely both sites of the Siamaná Formation.

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VARIABILITY OF TUNA PREY ITEMS ALONG THE COAST OF SOUTHERN MINDANAO, PHILIPPINES (Abstract ID: 29246 | Poster ID: 274)

Tuna and its allies are migratory and are among the large predators in the marine pelagic environment. The abundance and distribution of tuna stocks are not limited to the actual extraction site but is dependent on the availability of their prey items. To supplement visual inspection of partially digested prey from the gut, molecular tools must be used to identify degraded prey items to give insights on the migration pattern of tuna in Mindanao. In this study, we report the identification of tuna prey from the gut contents of Yellowfin tuna landed in Sarangani and Zamboanga using COI DNA barcodes. A total of 69 guts were obtained from the public markets. Initial results revealed that prey items of Yellowfin tuna differ in the 2 landing sites in Philippines. In Sarangani, tuna prey was primarily several small tuna species, Thunnus albacares (33.4%) , Thunnus atlanticus (11.1%), Thunnus obesus (11.1%), Thunnus tonggol (11.1%) and Thunnus Maccoyii (11.1%), Pinktail triggerfish (Melichthys vidua, 11.1 %) and Duckbill barracudina (Magnisudis atlantica, 11.1%) while in Zamboanga, it is Bigeye cigarfish (Cubiceps pauciradiatus, 60.0%), and small Yellowfin tuna (Thunnus albacares, 40.0%). However, predator-prey relationships in tuna must be interpreted with caution as it may be influenced by the use of bait and/or the catching practices in each site.

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USING 3D SCANNING TO QUANTIFY CORAL MORPHOLOGY (Abstract ID: 28681)

Scleractinian coral species exhibit a diverse range of morphologies, some of which vary significantly across environmental gradients such as light and wave energy. Morphology determines two key coral traits: surface area and volume. Surface area relates to a colony's capacity for photosynthesis, heterotrophy and reproduction. Colony volume relates to mechanical damage thresholds and resource acquisition. Therefore, morphology is a fundamental determinant of the ecological success of corals; driving species coexistence, competition and community structure. However, due to technological limitations, morphology is typically categorised (e.g., branching, tabular) and research based on quantitative measurements of morphology is slow, expensive, inaccurate and/or restricted by portability. Here we present results using handheld 3D laser scanning to quantitatively measure morphological traits across a range of morphologies. Specifically, we compare how surface area, volume and planar area, relate to morphological groups and attempt to collapse colony morphology into a few continuous axes of individual level variation in morphology. Of these, surface area to volume ratios stand out as a key trait for comparing how growth form categories can be arranged on a quantitative continuum. We propose a hypothesis on how surface area to volume ratios may explain differences in coral demographic rates, highlighting the potential advantages of moving towards a quantitative framework of coral morphology.

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CONSERVATION GENETICS APPROACHES TO ASEXUAL CORAL RESTORATION ACTIVITIES (Abstract ID: 27914)

The elucidations of the present population structure and genetic diversity are of fundamental importance in establishment effective conservation measures of coral reefs. Coral reefs have various values, but have been decreasing around the world by both global climate change and local anthropogenic effects. In the past decade, coral transplantation has been recognized as a prime management tool for restoration. Asexually method of transplantation has been conducted in many places of the world. However, there has been concern about adverse effects of transplantation for the purpose of restoration, such as loss of genetic diversity, break down local genetic structures and genetic introgression. To compare genetic diversity between cultured and wild population, we studied with *Acropora tenuis*through the Nansei Islands, Japan by using 13 microsatellite markers. For wild population, we assessed the population structure and genetic diversity of 298

colonies from 15 localities. We found that *A. tenuis* did not propagate by asexual way in the wild. The genetic diversity was not significantly different among populations even in possibly peripheral distribution. In addition, our results show that there are at least two major populations of *A. tenuis* in the Nansei Is. For cultured population, we studied 155 colonies from 3 coral farms in Okinawajima Island, Japan. The genetic diversity of each farm is compared with that of wild populations. We believe that accurate evaluations using genetic tools will be valuable for successful restoration of coral reefs.

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SIZE-STRUCTURAL SHIFTS REVEAL INTENSITY OF EXPLOITATION IN CORAL REEF FISHERIES (Abstract ID: 29832)

Fisheries represent a considerable threat to coral reef resources because fishers typically target large-bodied species. Although species occupying higher trophic groups are known to suffer a majority of the exploitative effects, changes in composition among lower trophic groups may be significant. Using size-based biomass spectra analysis, we investigate the effects of fishing on the size-structure of fish assemblages and determine if patterns of exploitation vary across trophic groups. Our analyses reveal striking evidence for the effects exploitation can have on fish assemblages. When examining biomass spectra across the entire assemblage we found consistent evidence of "size-specific exploitation", a process by which large-bodied individuals experience disproportionate reductions within the top predatory trophic group. However, when assemblages were analyzed among trophic groups, two additional forms of exploitation were realized; "size-biased exploitation", in which all sizes are exploited with a bias toward greater proportional effect on larger-bodied individuals, and "size-neutral exploitation", in which proportional exploitation is equivalent across all size classes. Importantly, the breadth of size classes and trophic groups that showed evidence of exploitation related positively to local human population density and diversity of fishing methods employed. Our findings highlight the complexity of coral reef fisheries and that the effects of exploitation are realized across multiple trophic groups and not solely restricted to large-bodied top-predators.

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AN OUTBREAK OF A SESSILE SEA CUCUMBER REDUCES POST-SETTLEMENT SURVIVORSHIP OF CORAL RECRUITS (Abstract ID: 28561)

An outbreak of sessile sea cucumbers, Ocnus Sanya, occurred on the degraded Luhuitou coral reef in Sanya Bay, Hainan, China. This study explored the pattern of distribution of O. Sanya on the reef, and the impacts of high abundance of O. Sanya on post-settlement mortality of Pocillopora damicornis recruits. The average density of O. Sanya reached 2000 individuals m-2 on hard substrate in 4m depth, which is significant higher than those on 2m and 6m depth, and the average coverage on hard substrate ranged from 11.95 to 23.69% between 2m and 6m depth. With O. Sanya (821.5 ± 160.9 individuals m-2, mean ± SD) on the surface, the tiles had 19.7% more surface sediment than those without sea cucumbers. The settled P. damicornis recruits showed significant higher mortalities on the terracotta tiles with O. Sanya than the control tiles after 3 weeks, in which the average survivorships of recruits with low and high O. Sanya density (649.3 ± 207.3 and 1126 ± 250 individuals m-2 respectively, mean ± SD) were only half and one third of that of recruits on control tiles. The higher O. Sanya density resulted in lower survivorship of coral recruits on tiles, although was not significant. These results suggested that the outbreak of O. Sanya hinders coral recruits recovery, and will deteriorate the sediment stress on coral recruits.

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MODEL SUGGESTS CORAL POPULATION RECOVERY AFTER REMOVAL OF ANTHROPOGENIC DISTURBANCE (LUHUITOU, HAINAN, SOUTH CHINA SEA) (Abstract ID: 28108 | Poster ID: 531)

Luhuitou reef is a fringing reef at Hainan Island, South China Sea. Coral communities suffered dramatic decline over the past 50 years under chronic anthropogenic disturbances. Since the establishment of a marine reserve in the 1990s, the frequency and intensity of disturbances declined. Massive Porites dominate in the current coral communities. A matrix population model was based on size-frequency data from field work and projected population trajectories over 100 years under no disturbance and random disturbances. The model reflects a largely open population of massive Porites, with low local recruitment and preponderance of imported recruitment. Under no further disturbance, the population of massive Porites will grow and its size structure will change from predominance of small size classes to large size classes. Therewith, total Porites cover will increase. Even under random disturbances between 10 and 20 years, the Porites population could remain viable, albeit at lower space cover. The models suggest recovery at Luhuitou following the removal of chronic anthropogenic disturbance. Extending the area of coral reef reserve to protect the open coral community and the path of connectivity is advisable and imperative in the conservation of Hainan's coral reefs.

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MICROBIOME DYNAMICS IN EARLY LIFE STAGES OF SCLERACTINIAN CORAL ACROPORA GEMMIFERA (Abstract ID: 28288 | Poster ID: 145)

Reef-building coral health highly depends on associated microbes, but little is known how they are developed at different coral developmental stages. Here, we conduct a case study to elucidate the establishment of coral associated microbes through coral life cycle. The microbiota of scleractinian coral *Acropora gemmifera* at various developmental stages were explored by high-throughput 16S rDNA sequencing analysis. Our results show that microbial communities in eggs are highly similar to parental adults, suggesting host coral can vertically transmit microbes to its offspring. Such new finding broadens our understanding of vertical transmission of associated microbes in corals. Microbial community structures were shifted differently from eggs to juveniles. Such variations may be related to coral development and environmental factors. Some specific microbes were accumulated at certain developmental stage. For example, the phylum *Cyanobacteria* was particularly abundant at juveniles and its abundance in 6-day-old juvenile was higher than that in 31-day-old. In contrast, the genus*Ruegeria* affiliating to *Rosebacter* clade was all detected through the life cycle. In conclusion, coral eggs can obtain associated microbes by vertical transmission, but the microbial community structures varied more during the coral offspring development from eggs to juveniles.

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CORAL MICROBIOMES AND HEAT STRESS – TESTING THE PROBIOTIC HYPOTHESIS IN A LONG-TERM RECIPROCAL TRANSPLANTATION EXPERIMENT (Abstract ID: 28016)

Ocean warming is an immediate threat to coral reef ecosystems worldwide, and it remains unknown to what extent the coral-associated microbial community may contribute to coral resilience. To begin to address this question, we used a long-term reciprocal transplantation experiment of Acropora hyacinthus between two thermally distinct backreef pools on Ofu Island, American Samoa. Native coral colonies in the two pools had different microbial communities. Moreover, after 17 months of transplantation, microbiomes of non-native corals transplanted into each pool adjusted to the new environmental conditions and were not significantly different from native corals in the same pool. In short-term heat stress experiments, the microbial community responded within 20 hours for corals that had been transplanted to a more stable, cooler environment. But

colonies living in the warmer, more variable environment for 17 months bleached less and maintained their original microbial communities. The robust and stable microbiome of the highly variable pool was characterized by a consistent set of microbial taxa across all control and heat treatments that were not (or only rarely) present in the susceptible corals transplanted to the more stable, cooler pool. Overall, our data provide evidence for a community of microbes associated with heat resistance patterns of corals across variable habitats. Whether these microbial differences influence thermal resilience, or are influenced by it, remains to be determined.

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ASYMMETRICAL MESOPREDATOR RELEASE: MORAY EELS INCONSPICUOUSLY PREDOMINATE HEAVILY FISHED REEFS (Abstract ID: 29640 | Poster ID: 253)

Populations of apex predators have declined globally due to human activities. In the absence of sufficient top-down control, mid-level predators can increase drastically in number (termed "mesopredator release"), which may lead to a trophic cascade that severely impacts the bottom-level prey populations in an ecosystem. On densely populated, accessible coastlines of the Main Hawaiian Islands, few large piscivorous fish remain. Nonetheless, these habitats are not functionally devoid of apex predators; rather, on heavily fished reefs, fishermen act as a top predator in the system. However, prey selectivities of humans differ from that of the natural predator assemblage, exerting high levels of top-down control on some targeted fishes and little pressure on non-target species, such as moray eels. Due to their cryptic nature, moray eels are underestimated in visual fish surveys. Consequently, almost no accurate data is available on eel abundances over space or time. Here, we developed a novel eel surveying technique that involves chum deployment on a defined transect to obtain a more accurate eel density estimate. We use this method to then examine how the eel biomass density relative to other reef fishes changes across a gradient of fishing intensity. We hypothesize that the reduction and replacement of natural apex predators with human predators has led to an asymmetrical release of moray eels from top-down control in heavily fished areas.
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REDUCED METABOLISM, LIMITED STAMINA: ECOLOGICAL IMPLICATIONS OF ELEVATED CO2 ON A KEY GRAZER (Abstract ID: 30062 | Poster ID: 381)

Ocean acidification has been identified as a threat to coral reef communities in subtropical and tropical regions. Studies have indicated that fish may have positive, negative, or neutral physiological responses to elevated CO2, and these responses are likely species-specific. More recently, research has indicated that elevated CO2 has a pronounced effect on the behavior (e.g., predator evasion) of many coral reef fish. Very little research has addressed how grazers, key to coral reef health, may respond to acidified seawater predicted to occur as the climate changes. The purpose of this experiment was to assess the feeding behavior, swimming performance, and metabolic responses of parrotfish exposed to CO2-acidified seawater. To do this, striped parrotfish (Scarus iserti) were acclimated to ambient sea water at 8.2 pH, seawater manipulated to a pH of 7.9, and seawater manipulated to a pH of 7.6 over a 24 hour period and held in these conditions for 14 days. Parrotfish exposed to a pH of 7.6 experienced lower metabolic rates while processing food relative to fish in ambient seawater. Fish chased until exhaustion traveled shorter distances and fatigued more quickly in CO2-acidified seawater relative to control conditions. Ocean acidification may impair digestion, thereby, limiting growth and reproduction in striped parrotfish. In combination with elevated mortality due to inability to escape predators, parrotfish may have a reduced capacity to manage algal growth on coral reefs.

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INCREASING THE RESILIENCE OF CORAL REEFS AND INFRASTRUCTURE TO CLIMATE CHANGE THREATS IN BARBADOS BY IDENTIFYING, CHARACTERIZNG AND ADDRESSING LOCAL STRESSORS (Abstract ID: 29830 | Poster ID: 459)

Coral reefs of islands nations are threatened by climate change and land-based anthropogenic pollution. Preserving and enhancing the resiliency of these coral reefs to climate change is paramount as a conservation measure and to reduce coastal hazards. A more resilient coastal zone is an important component of sustaining the overall economic and social health of Barbados. The Barbados Coastal Zone Management Unit is presently executing the Coastal Risk Assessment and Management Program (CRMP). The goals of the Ecosystem Based Adaptation Pilot Project, one aspect of the CRMP, include: 1) identify and characterizing land and marine based sources of stress that impact fringing reefs, 2) completing a coral nursery pilot project to support fringing reef restoration, and 3) develop a future hierarchical-management strategy to mitigate the major factors that degrade the resiliency of the fringing reefs. During the field program we collected specific parameters to be used as "markers for management effectiveness." The various factors affecting coral reef resiliency will be discussed as well as the two primary processes: eutrophication and chemical pollution. The sources of nutrients (sewage vs. agriculture) driving the eutrophication were characterized spatially and over time. Numerical modeling tools were used to investigate the potential benefits of future reef restoration efforts on wave energy dissipation, reductions in beach erosion, and storm damage mitigation. Coupling pollution forensics with coral aquaculture and restoration is a strategy to increase coastal resiliency.
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ANALYZING DISTRIBUTION OF CORAL RECRUITS USING FLUORESCENCE IMAGING (Abstract ID: 28151)

Coral recruitment is a fundamental process that influences coral population dynamics as well as reef community structure. Formation of new juvenile colonies is essential for recovery and indicates good conditions for development and growth of coral reefs. To date, coral recruitment success rates are poorly described; therefore developing an effective survey method for coral recruits distribution analysis is essential. Due to the fact that corals and their symbiotic algae both contain florescence pigments, (chlorophyll-a and fluorescent proteins), we used the FluorIS- Fluorescence Imaging System, to develop a non-invasive method to identify coral recruits in situ during daytime. In this study we tested the efficiency and accuracy of this method by monitoring twenty random quadrats for ten months. Our results show that this low cost, easy to use method, reduces errors in identification formed by other fluorescent organisms (e.g. algae, sponges and worms) and/or surveyor errors. Using this time series we positively identified coral recruits as small as 0.2 cm in diameter and were able to record their settlement, growth and mortality. World's coral reefs are declining and at risk of collapse as a result of local and global stressors. Understanding physiology and survival of coral recruits will improve future predictions of their ability to resist, respond and recover under stress.

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EFFECTS OF ELEVATED $PCO_2$ ON PHOTOSYNTHESIS IN TROPICAL MACROALGAE (Abstract ID: 29736 | Poster ID: 284)

As ocean pH decreases due to increasing atmospheric anthropogenic CO2, the levels of pCO2 and HCO3- available in seawater for photosynthesis increases. Little is known about how photosynthesis in macroalgal species will be affected. Different species may have varying responses due to species-specific inorganic carbon uptake mechanisms. We hypothesize that elevated pCO2 will increase photosynthetic rates of tropical macroalgae that are undersaturated by current DIC levels (~2 mM), or that possess ineffective carbon concentrating mechanisms. We studied eight species of calcifying and fleshy tropical macroalgae chosen for their ecological significance on coral reefs. All species were collected from the same shallow (~5 m) patch reef site along the Florida Reef Tract. Photosynthetic rates were determined at three pH levels (7.8, 8.1 and 8.4) to determine the effects of CO2 availability on DIC uptake. At each pH level, photosynthesis was determined across a range of irradiances to examine the energetic requirements of DIC uptake. To discern inorganic carbon uptake mechanisms, we measured photosynthetic rates in the presence and absence of inhibitors of internal and external carbonic anhydrase (AZ and EZ). We found that species had varying responses to elevated pCO2, but that the majority showed an increase in photosynthetic rates at lower pH. Some, but not all species showed a reliance on CA to promote photosynthesis. Our results suggest that species-specific inorganic carbon uptake mechanisms likely play a role in macroalgal responses to elevated pCO2.

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