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REEF ENCOUNTER

The News Journal of the
International Society for Reef Studies

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REEF ENCOUNTER

Reef Encounter is the Newsletter and Magazine Style Journal of the International Society for Reef Studies. It was first published in 1983. Following a short break in production we are re-launching it in electronic (pdf) form. Contributions are welcome, especially from members. Please submit items directly to the relevant editor (see the back cover for author's instructions).

INTERNATIONAL SOCIETY FOR REEF STUDIES

The International Society for Reef Studies was founded in 1980 at a meeting in Cambridge, UK. Its aim under the constitution is to promote, for the benefit of the public, the production and dissemination of scientific knowledge and understanding concerning coral reefs, both living and fossil.

CORAL REEFS - THE JOURNAL

The International Society for Reef Studies also publishes through Springer's its premier scientific journal entitled "CORAL REEFS". The Journal publishes high quality scientific papers concerning the broad range of fields relevant to both modern and ancient reefs. (see http://www.springer.com/life+sciences/ecology/journal/338)

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COVER PICTURE: **Nanhanari Reef, Kume Island, Okinawa.** The picture shows the coral community composed mainly of *Acropora horrida*, spread over an area several kilometers in length and 200 m in width, as it was before the 2011 typhoon in which it was severely damaged. (See the report on the 14th JCRS Meeting for further detail.) Photo by Atsuo Shioiri.

EDITORIAL

The Re-launch of Reef Encounter

As wiser heads than mine will know, one downside of making a helpful suggestion is that, come push to shove, colleagues tend to look your way when it comes to getting the thing done. Thus have I inherited the somewhat thankless role of editor (at least for the time being) of Reef Encounter. This is a task that has been fulfilled by a series of worthy predecessors (including indeed two of my own PhD students) whose thoroughness I can only hope to emulate.

Reef Encounter has suffered a pause in publication this past few years, this for several reasons. The cost of printing and postage was becoming too high in relation to membership dues, and many of the traditional functions of a newsletter have been taken over by websites, email discussion lists (like coral-list) and the social media. Thus Reef Encounter is being re-launched[1] as an electronic news journal for distribution as a pdf file, or downloading from the society's website. At the same time, given less need to incorporate ephemeral news, this format actually permits a larger publication, with the possibility of incorporating short scientific papers and reports.

We have taken a step in this direction with our new "Reef Edge" section that offers members a chance to record new observations or data that, while not substantive enough to warrant a longer paper in Coral Reefs or another journal, may nevertheless be of real value in the increasingly urgent task of understanding and managing coral reef ecosystems. We encourage members to consider whether they have information or ideas that deserve to be put on record in this way. However, we do expect contributions to this and other sections to be increasingly carefully refereed as the numbers of submissions rise. The instructions to potential authors for each type of article are provided on the back pages of this edition.

Finally I should thank the impressive number of members who have responded to the appeal to help "re-launch the Reef Encounter vessel", by either agreeing to act as section editors or offering articles or items for publication. I am enormously grateful to them. I hope many more of you will be willing to follow their lead by contributing to the next edition which we hope to publish this coming June (2014).

Rupert Ormond

Corresponding Secretary ISRS & Editor Reef Encounter
Honorary Professor Heriot-Watt University, Edinburgh, UK
Research Professor, King Abdul-Aziz University, Jeddah, Saudi Arabia

[1] **A Note on Numbering:** After much discussion we have decided to take the likely controversial step of altering the Reef Encounter issue numbering system to bring it into line with that of most journals. This edition is in fact the 39th in a line stretching back to the Newsletter's launch in 1983. However, since I believe this is the 29th separate year in which editions will have been published, I have opted to call this issue "Volume 29, number 1". I trust I will not offend too many members by this taxonomic change!

PRESIDENT'S MESSAGE

Dear ISRS Colleagues,

On behalf of the officers and council members of the International Society for Reef Studies, I am pleased to report that the state of the Society is strong and we look forward to a year of continued growth and expansion of services to our members as well as new opportunities and activities. The new online membership renewal system is working well, and other cost saving measures undertaken have resulted in financial stability for ISRS. A key goal in the coming year is to reinstate student fellowship support, as well as offer opportunities for members to engage in activities that more effectively bridge the results of our scientific research to support and guide policy development for the preservation of coral reefs globally. I would like to extend a special thanks to Rupert Ormond and our other colleagues who have resurrected *Reef Encounter*, the ISRS newsletter, in its new format as a digital, online publication. This should increase opportunities for sharing information, opportunities and ideas among our members.

Planning is continuing for the 13th International Coral Reef Symposium, which will be held in Honolulu, Hawaii, June 19-24, 2016. I am looking for members willing to chair and participate in the various organizational committees, and would like to solicit input on ideas and activities that will enrich the experience of those attending the meeting. I am hoping we can make use of expanding technology to set up regional hubs where coral reef scientists, students, managers and policy makers who are unable to travel to Hawaii, can still participate "electronically," and would welcome feedback from those who would like to host some remote sites. The ISRS officers and council have also been working on fund raising strategies to support this and other activities including more frequent regional meetings and enhanced opportunities for collaborations among members. Don Potts, the ISRS treasurer, has taken the lead to develop a sustainable funding plan, which includes reaching out to foundations for supporting key society activities.

Dr. Howard Lasker has recently taken over as Editor-in-Chief of our journal, Coral Reefs, from Dr. Rolf Bak. We thank both Rolf and the Deputy Editor Dr. Betsy Gladfelter for the tremendous efforts they have put in over the years in overseeing a world-class publication of which we can all be proud. Online access to Coral Reefs should now be working smoothly (no more tokens!), thanks to additional support from Springer. Elections for new officers will be coming up at the end of 2014, so please give some though as to nominations and your willingness to serve the Society as we continue to move towards the active engagement of the broader membership through a variety of committees.

I encourage ISRS members to contact me and the other officers and council members with any ideas and input that will help the Society. A strong ISRS is needed more than ever at time when coral reefs are in desperate need of our collective expertise and efforts at protection and bridging the best science to policy, management, conservation and education.

Best wishes,

Bob Richmond

President, International Society for Reef Studies
Professor, University of Hawai'i at Manoa, Hawaii, USA

OFFICERS' REPORTS

New Society Website

A subcommittee on website development is working to update and refresh our society's place on the web. Our goal is to make the website both stunning and informative and in short, the place to go for information about coral reefs. To do this work, we were extremely fortunate to acquire pro bono services of DeepBlue, a web design firm headquartered in Atlanta, Georgia (USA). They are especially well known for responsive web designs that allow a broad range of platforms including mobile devices to easily access information on the website. Their client list is quite impressive and include NASA, Intel, and Emory University. To find out more about DeepBlue and some of their work, go to: www.deepblue.com.

As part of this effort, we invite you to submit your favorite coral reef photos for possible use on the website. If you are interested, please send your photo or photos to me, Kiho Kim at kiho@american.edu. Please include information about date, location, and a brief description, and the following statement: "I am the owner of the image and I give ISRS permission for its use on the website."

We are hoping that we will have the new website up by early spring of 2014 so stay tuned!

Kiho Kim
ISRS Minutes Secretary & Chair Website Committee
Associate Professor, American University, Washington DC, USA

Society Finances

Over the course of several years, ISRS finances gradually became unsustainable as expenses increasingly exceeded income from membership. This was driven by the terms of our previous contract for business services which became increasingly ill-suited to meet the changing nature of our membership and the accelerating shift towards universal electronic communication and publishing. In mid-2012, ISRS signed a contract with a new supplier of business services, The Schneider Group (SG) in Waco (Texas). SG is very experienced supporting smaller academic societies and their activities, including organization of meetings and conferences. Over the last 18 months, SG has been working closely and interactively with ISRS officers, suggesting ways to minimize costs and enhance revenues, giving advice on how to maximize services to members, and assisting with planning for the 13th International Coral Reef Symposium in 2016.

As of 31st January 2013, ISRS has a balance of $US 40,315.61 with no outstanding obligations, and projections that income will exceed expenditures for the foreseeable future, enabling the Society to accumulate funds for supporting other activities. One small way in which every member can assist the Society is by responding promptly to email and internet requests for membership renewals, so that we avoid the considerable cost of mailing individualized paper reminders.

An even more valuable way to increase both the financial and institutional strengths of ISRS, and hence expand its effectiveness as an organization promoting coral reef science and communicating that science to the public, managers and policymakers, is to encourage colleagues, students and friends to join ISRS. We especially ask you to encourage people in less developed countries to take advantage of our reduced membership dues.

Donald Potts
ISRS Treasurer
Professor of Biology, University of California at Santa Cruz, California, USA

ANNOUNCEMENTS

13th International Coral Reef Symposium

The 13th International Coral Reef Symposium (ICRS 13) will be held in Honolulu, Hawaii, June 19-24, 2016, and will be organised by ISRS. Arrangements and fund-raising are already well-advanced, but we are looking for members willing to chair and participate in the various organizational committees. We would also welcome input on ideas and activities that will enrich the experience of those attending the meeting. For example it is hoped that we can make use of expanding technology to set up regional hubs where coral reef scientists, students, managers and policy makers who are unable to travel to Hawaii, can still participate "electronically," and would welcome feedback from those who would like to host some remote sites. Please do not hesitate to contact me or another ISRS officer.

Robert Richmond

Coral Disease Mini-Symposium at Asia Pacific Regional Symposium

We would like announce that there will be a mini-symposium on 'Coral Disease in the Asia-Pacific region' at the upcoming 3rd Asia Pacific Coral Reef Symposium in Taiwan, 23-27th June 2014 (http://www.apcrs2014.com). Coral disease has emerged as a serious threat contributing to the decline of reefs all over the world. In the past few decades, there has been a sharp increase in the frequency and severity of coral diseases with resultant impacts on coral cover, species diversity and reef ecosystem structure and function. However, we know very little about the distribution, prevalence and cause of most coral diseases in the Asia-Pacific region. This mini-symposium is organized to provide an update on advances in marine disease research and management, and to build networks of coral disease scientists in the Asia-Pacific. We welcome abstracts and presentations on this topic and look forward to creating an Indo Pacific network of coral disease experts. Please submit your abstracts online to Mini-symposium #8 but if you have any questions or would like more information please contact Greta Aeby (greta@hawaii.edu) or Joanne Wilson (jwilsonmarine@gmail.com).

Joanne Wilson and Greta Aeby

Free Copies of Reef Encounter Back Numbers

There are still hard copy back numbers available of most editions of Reef Encounter. It is anticipated that pdf versions of all back numbers will be available on the society's re-vamped website and sooner rather than later the store of back numbers will need to be disposed of. However some members may like to replace hard copy versions missing from their private collection (where they have for example been "borrowed" by a student or left on a plane!?). Or others may like to see the complete run available in their Laboratory or University libraries. If so, please contact founding editor Brian Rosen at the Natural History Museum, London (email: b.rosen@nhm.ac.uk), who can provide further details.

Brian Rosen

European Coral Reef Symposium Delayed

We regret to inform members that it has been necessary to postpone the next "European Coral Reef Symposium" which we were previously hoping to hold at the CRETAQUARIUM in Heraklion, Crete, Greece in early October 2014. We now hope that it may be possible to re-schedule the meeting for Spring 2015. Any member who would like to obtain further information or to assist with the organisation of meeting, please contact Aspasia Sterioti at the Crete Aquarium (email: aspasia@her.hcmr.gr). For more information on the Cretaquarium please see: www. cretaquarium.gr.

Aspasia Sterioti

REEF NEWS

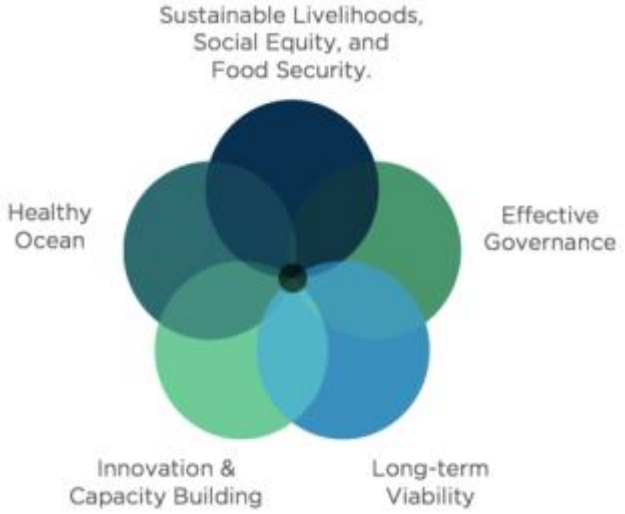
Resolving the Coral Reef Crisis - partnerships, principles and the public good.

A unique panel of business, government, conservation and academic leaders has agreed a global strategy for aligning ocean health and human well-being. The report of the panel, entitled **"Indispensable Ocean"**, was released on 16 October 2013. The ***Blue Ribbon Panel***, which includes 21 global experts from 16 countries, emphasizes that without action to turn around the declining health of the ocean, the consequences for economies, communities and ecosystems will be irreversible.

Convened by the World Bank to advise the **Global Partnership for Oceans** (GPO), the Panel includes high-level players ranging from CEOs of some of the largest seafood companies in the world - including Thai Union Frozen Products, Bumble Bee Foods and High Liner Foods - to government officials and prominent marine conservationists. The panel is chaired by Ove Hoegh-Guldberg.

According to the panel, fragmented approaches that fail to consider social, political, economic and ecological relationships will fail to meet the complex challenges facing ocean health. The report calls for an integrated approach to ocean investment and emphasizes the essential role of public-private partnerships.

Therefore, it proposes these five principles to ensure ocean investments: (1) sustainable livelihoods, social equity and food security; (2) a healthy ocean; (3) effective governance systems; (4) long-term viability and (5) capacity building and innovation. Coral reef workers will recognize this framework arising from the Sustainable Livelihoods Approach of the 2010s … what is inspiring is that the Panel, with its mix of economists, private sector and other non-scientists felt that the same principles could be applied not only



to the subsistence community scale, but all the way up to regional and global scales to fix the common property problems of the oceans.

The Panel's principle-based strategy provides an approach to prioritize where, when and how partnerships can take action with high impact. The panel recommends that the principles be incorporated into all levels of reform - from fisheries management to incentives for pollution reduction to habitat restoration. In parallel with the Panel, the GPO also ran a **Habitats working group**, that set out a more detailed agenda and targets for restoring ocean habitats. The panel agreed that the Global Partnership for Oceans is a platform that brings together the multi-stakeholder support, technical expertise and finance needed to change the course on oceans.

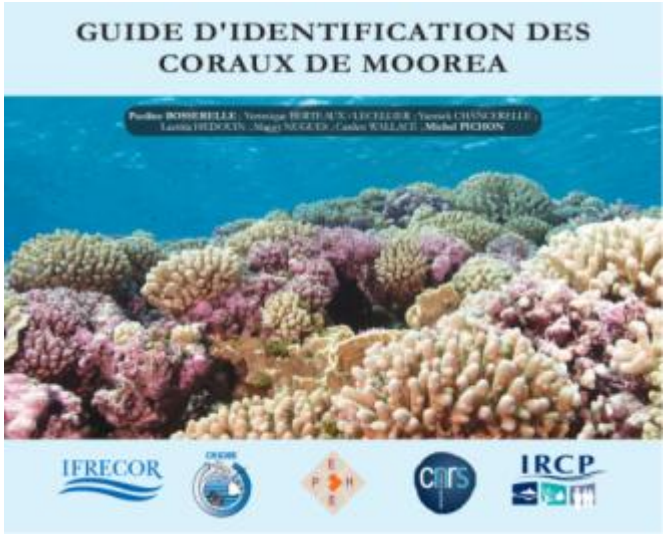
Further information plus the full report is available at: www.globalpartnershipforoceans.org/indispensable-ocean, while further comment is available @GPOceans on Twitter. Members are urged to "try the approach on for size" in developing practical solutions to reef degradation.

About the Blue Ribbon Panel: Convened by the World Bank, the Blue Ribbon Panel comprises leaders from 16 countries, representing government, the private sector, civil society organizations, academia, and multi-lateral institutions. The Panel was tasked with providing recommendations to the Global Partnership

for Oceans on the principles and practices for prioritizing and implementing sustainable ocean investment. For more on the Blue Ribbon Panel, visit: http://www.globalpartnership foroceans.org/blue-ribbon-panel.

About the Global Partnership for Oceans: The GPO is a new and powerful approach to restoring ocean health. It mobilizes finance and knowledge to activate proven solutions at an unprecedented scale for the benefit of communities, countries and global well-being. The GPO is now a growing alliance of over 140 governments, international organizations, civil society groups, and private sector interests committed to addressing the threats to the health, productivity and resilience of the ocean. It aims to tackle widely documented problems of overfishing, pollution, and habitat loss. For more information on the Global Partnership for Oceans, visit: http://www.globalpartnershipforoceans.org. (*David Obura*)

New Coral Guide for Moorea Published



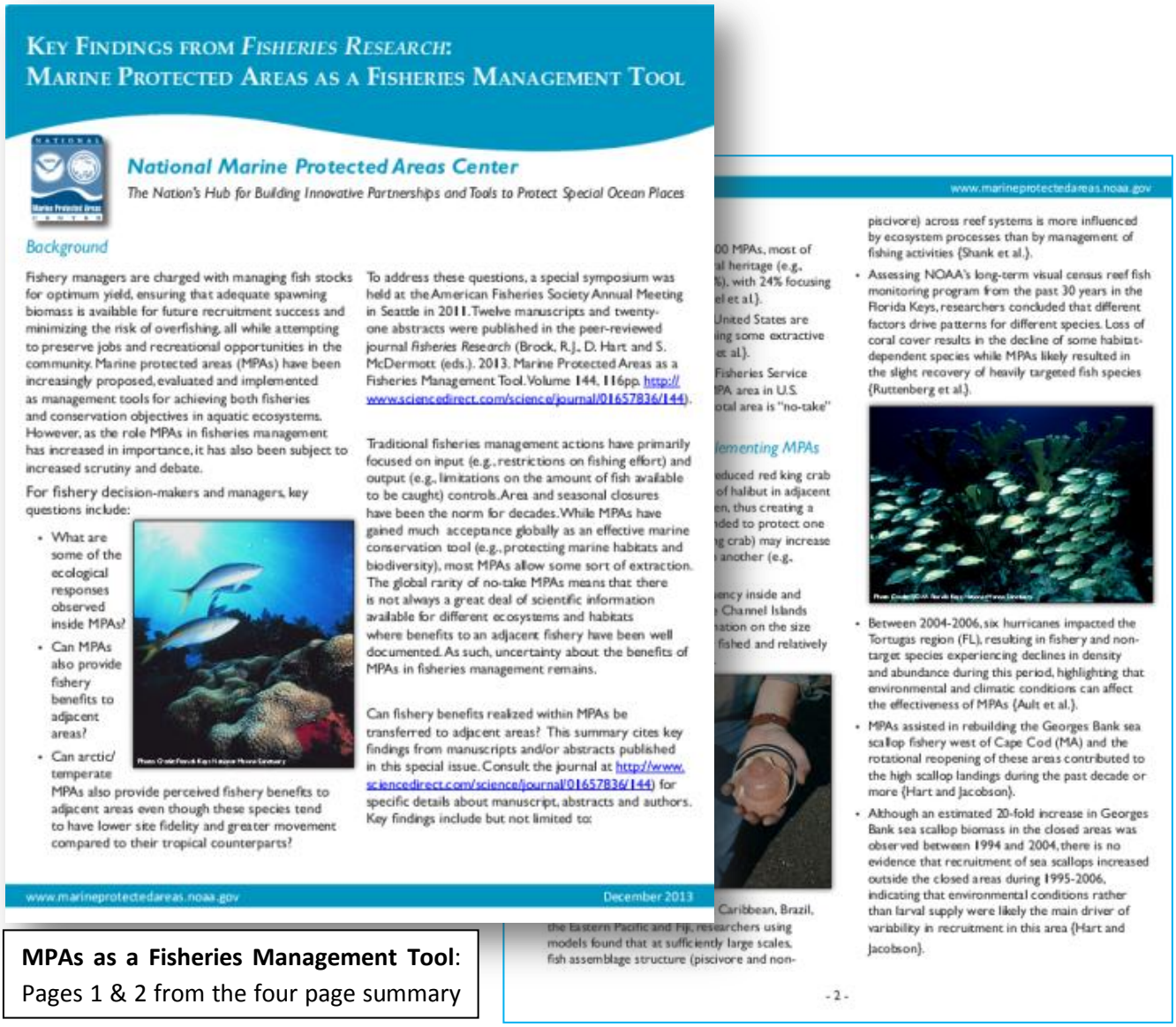
A new coral guide, the "*Guide d'Identification des Coraux de Moorea*", written by scientists from the «Centre de Recherches Insulaires et Observatoire de l'Environement» (CRIOBE) has now been published, by the same institute. It provides detailed information on the identity of 67 of the most common hard coral species found in the reefs surrounding Moorea. It also includes general information on the reefs of Moorea and the morphology and ecology of reef corals, an identification key of the genera found in Moorea, and a short diagnosis of each of the species included in the account. It is illustrated with pictures of live specimens *in situ* and of the characteristic skeletal features. A list of literature references, a glossary and an index complete this handsomely presented volume. It should be of interest to coral reef scientists, university and secondary school students, divers, underwater photographers and the ecologically minded tourists visiting the central Pacific. (*Michel Pichon*)

Full reference : Bosserelle P., Berteaux-Lecellier V., Chancerelle Y., Hédouin L., Nugues M., Wallace C. & Pichon M., 2014***. Guide d'identification des coraux de Moorea***. CRIOBE 120p. ISBN: 978-2-9547466-0-9. (In French). For enquiries or orders, please write to Association Opunohu Criobe, BP 1013 PAPETOAI, 98729 MOOREA, FRENCH POLYNESIA, or email: asso.opunohu@criobe.pf

An illustration from the Moorea Guide: *Montipora capitata* (Dana, 1846), a new record for French Polynesia.

Marine Protected Areas as a Fisheries Management Tool

Twelve peer reviewed manuscripts and 21 abstracts from the 2011 American Fisheries Society special symposium "*Marine Protected Areas as a Fisheries Management Tool"* were published in *Fisheries Research* in July 2013. The U.S. National Oceanic & Atmospheric Administration (NOAA) National Marine Protected Areas Center has synthesized the "key findings" as an easy to read brochure or pdf file. This can be found at the National MPA Center site and at: http://marineprotectedareasnoaa.gov/sciencestewardship/mpascience. (Robert Brock)



KEY FINDINGS FROM *FISHERIES RESEARCH*:
MARINE PROTECTED AREAS AS A FISHERIES MANAGEMENT TOOL

National Marine Protected Areas Center
The Nation's Hub for Building Innovative Partnerships and Tools to Protect Special Ocean Places

Background

Fishery managers are charged with managing fish stocks for optimum yield, ensuring that adequate spawning biomass is available for future recruitment success and minimizing the risk of overfishing, all while attempting to preserve jobs and recreational opportunities in the community. Marine protected areas (MPAs) have been increasingly proposed, evaluated and implemented as management tools for achieving both fisheries and conservation objectives in aquatic ecosystems. However, as the role MPAs in fisheries management has increased in importance, it has also been subject to increased scrutiny and debate.

For fishery decision-makers and managers, key questions include:

- What are some of the ecological responses observed inside MPAs?
- Can MPAs also provide fishery benefits to adjacent areas?
- Can arctic/temperate MPAs also provide perceived fishery benefits to adjacent areas even though these species tend to have lower site fidelity and greater movement compared to their tropical counterparts?

To address these questions, a special symposium was held at the American Fisheries Society Annual Meeting in Seattle in 2011. Twelve manuscripts and twenty-one abstracts were published in the peer-reviewed journal *Fisheries Research* (Brock, R.J., D. Hart and S. McDermott (eds.). 2013. Marine Protected Areas as a Fisheries Management Tool. Volume 144, 116pp. http://www.sciencedirect.com/science/journal/01657836/144).

Traditional fisheries management actions have primarily focused on input (e.g., restrictions on fishing effort) and output (e.g., limitations on the amount of fish available to be caught) controls. Area and seasonal closures have been the norm for decades. While MPAs have gained much acceptance globally as an effective marine conservation tool (e.g., protecting marine habitats and biodiversity), most MPAs allow some sort of extraction. The global rarity of no-take MPAs means that there is not always a great deal of scientific information available for different ecosystems and habitats where benefits to an adjacent fishery have been well documented. As such, uncertainty about the benefits of MPAs in fisheries management remains.

Can fishery benefits realized within MPAs be transferred to adjacent areas? This summary cites key findings from manuscripts and/or abstracts published in this special issue. Consult the journal at http://www.sciencedirect.com/science/journal/01657836/144) for specific details about manuscript, abstracts and authors. Key findings include but not limited to:

www.marineprotectedareas.noaa.gov December 2013

www.marineprotectedareas.noaa.gov

piscivore) across reef systems is more influenced by ecosystem processes than by management of fishing activities (Shank et al.).

- Assessing NOAA's long-term visual census reef fish monitoring program from the past 30 years in the Florida Keys, researchers concluded that different factors drive patterns for different species. Loss of coral cover results in the decline of some habitat-dependent species while MPAs likely resulted in the slight recovery of heavily targeted fish species (Ruttenberg et al.).
- Between 2004-2006, six hurricanes impacted the Tortugas region (FL), resulting in fishery and non-target species experiencing declines in density and abundance during this period, highlighting that environmental and climatic conditions can affect the effectiveness of MPAs (Ault et al.).
- MPAs assisted in rebuilding the Georges Bank sea scallop fishery west of Cape Cod (MA) and the rotational reopening of these areas contributed to the high scallop landings during the past decade or more (Hart and Jacobson).
- Although an estimated 20-fold increase in Georges Bank sea scallop biomass in the closed areas was observed between 1994 and 2004, there is no evidence that recruitment of sea scallops increased outside the closed areas during 1995-2006, indicating that environmental conditions rather than larval supply were likely the main driver of variability in recruitment in this area (Hart and Jacobson).

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MPAs as a Fisheries Management Tool: Pages 1 & 2 from the four page summary

Special Issue of Galaxea Promotes English Translations of Work by Dr. Siro Kawaguti

A supplement volume of Galaxea (the Journal of the Japanese Coral Reef Society) has been published to celebrate the great contribution to coral reef science made by Dr. Siro Kawaguti. His work has indeed been conspicuous and served as an inspiration for younger generations of marine scientists. His research was however mostly published in two periodicals published by the Palao (Palau) Tropical Biological Station: the *Palao Tropical Biological Station Studies* and "*Kagaku Nanyo*" (*Science of the South Sea*), the latter being published only in Japanese. The production of this special issue of Galaxea, in which Dr. Kawaguti's papers have been translated into English, has been the result of intensive voluntary work by young researchers in the Japanese Coral Reef Society (JCRS). It is hoped that the supplement will prove an important contribution to coral reef science and be of value to scientists throughout the world. Dr. Makoto Tsuchia (former president of the JCRS and Professor of the University of Ryukyus, Japan), in his introduction to the issue wrote "We have always been learning from history" meaning that in searching for solutions to the rehabilitation of damaged coral reefs, the accumulation of the scientific information through basic research is required. This special issue is available on-line in Galaxea at the JCRS website (http://www.jcrs.jp/?page_id=1550). (Beatriz Estela Casareto)

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Reef Perspectives: ESA Coral Species Listing

REEF PERSPECTIVES

Personal comment on reef science, policy and management

E.S.A. CORAL SPECIES LISTING: A ROADBLOCK TO COMMUNITY-BASED ENGAGEMENT IN CORAL REEF CONSERVATION AND REHABILITATION ACROSS THE U.S. CARIBBEAN?

Edwin A. Hernández-Delgado[1] and Samuel E. Suleimán-Ramos[2]

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Coral reef ecosystems have declined globally driven by multiple local-scale human stressors and large-scale climate change-related factors, which can produce a combination of acute, stochastic events, and long-term, slowly-evolving changes (Côté and Darling 2010, Hughes *et al*. 2013). Mounting evidence points to the wider Caribbean region as one of the most susceptible to rapid ecosystem resilience decline (Rogers and Miller 2006, Roff and Mumby 2012, Rogers 2013). This has often resulted in a long-term decline in percent live coral cover, species diversity and a widespread phase shift in benthic community structure (Hughes 1994, Miller *et al*. 2009, Edmunds 2013), with limited recovery ability (Hughes and Tanner 2000, Birkeland *et al*. 2013). It has also resulted in the demise of susceptible coral functional groups such as Atlantic acroporid corals (Bruckner and Hourigan 2000) and a major loss of coral reef ecosystem resilience, functions, benefits, services, and socio-economic value (Bellwood *et al*. 2004), including the ability to sustain fisheries (Pauley *et al*. 2002, Pauley and Zeller, 2014, Pratchett *et al*. 2014).

Nonetheless, a recent burst of various efforts at a global scale using low-tech coral farming and outplanting approaches have produced modest positive and highly promising results of propagating corals aimed at rehabilitating coral reefs and buffering their current trends of decline (Rinkevich 2014). Ecosystem rehabilitation can be defined as the recovery of specific ecosystem services in a degraded ecosystem or habitat. It seeks to repair damaged or blocked ecosystem functions, with the primary goal of raising ecosystem productivity for the benefit of local people (Aronson *et al*. 1993). In that sense, low-tech coral farming, which implements simple, low-cost, effective methods, seek to achieve reef rehabilitation of a set of minimum ecosystem functions as rapidly as possible using rapid-growing coral species.

Staghorn coral (*Acropora cervicornis*) farming in the Caribbean was first undertaken experimentally in 1980 in Puerto Rico by the late Carlos Goenaga and Vance P. Vicente. It was further developed by Bowden-Kerby (1997), Antonio Ortiz and Héctor Ruiz over the late 1990s, and has continuously been conducted in Culebra Island, off eastern Puerto Rico, since 2003, as an entirely community-based effort led by NGO Sociedad Ambiente Marino, in collaboration with NGO Coralations, the Culebra Island Fishers Association, and the Center for Applied Tropical Ecology and Conservation (CATEC) of the University of Puerto Rico (Fig. 1). Since then, multiple efforts have sprouted across the wider Caribbean region, including Puerto Rico, U.S. Virgin Islands, Belize, Jamaica, Dominican Republic, and Florida, to mention a few (Young *et al*. 2012). But these efforts have mostly been limited to smaller spatial scales and mostly focused on *A. cervicornis* largely due to logistical, technical and/or economic limitations.

There is widespread consensus across the Caribbean that people of coastal communities can effectively conduct low-tech coral farming, develop activities to

conserve and rehabilitate their local reefs, and promote community-based management of local resources through continued public education and awareness (Young *et al*. 2012), and hands-on experiences. Our particular twelve year-old experience in coral farming and outplanting in Puerto Rico through the *Community-Based Coral Aquaculture and Reef Rehabilitation Program* has unequivocally showed that community-based approaches have become a paramount tool to assist regulatory agencies and management institutions to enhance coral reef recovery and conservation through coral farming project outcomes (Fig 2). Community engagement can also foster enhanced stewardship and multiple educational/outreach benefits, and increase the level of technical training of local personnel. This has resulted in empowering and helping local communities and stakeholders to manage their coastal resources, which in the long run will result in improving their skills to protect their first line of defense against climate change and sea level rise.

Figure 1. Low-tech Staghorn coral *Acropora cervicornis* farming unit in Culebra Island, Puerto Rico. Rapid coral growth in farms results in the ability to produce multiple large fragments (20-50 cm) for outplanting to natural reef bottom.

The Culebra Island case study

In the particular case of Culebra Island, an important tourism destination located 27 km off eastern Puerto Rico, halfway between Puerto Rico and St. Thomas, USVI, coral farming and reef rehabilitation have triggered a major blooming of community-based low-impact tourism activities on local rehabilitated coral reefs within Canal Luis Peña No-take Natural Reserve.

Figure 2. The "Coral Condo" farming units supports outstanding coral growth and significant coral reef fish aggregations.

In this case, the no fishing designation has been implemented in combination with restocking of approximately 12,000 colonies of *A. cervicornis*. This has triggered a rapid increase in fish biomass, fish recruitment and herbivory across rehabilitated reef segments (Fig. 3). Such benefits would be particularly critical for developing nations and small island countries with very limited technical and financial resources available for management. Therefore, community-based participation in conservation- and management-oriented coral farming and reef rehabilitation activities has become a key component of modern coral reef day to day management strategies in a time of increasing socio-economic constraints and increasing climate change threats to the recovery and sustainability of reef ecosystem resilience. It represents a win-win situation for regulatory agencies, academia and the communities themselves, resulting in an increased direct involvement of multiple stakeholders in the decision-making process. It may also result in improved process transparency, communication and trust-building, and in building stronger partnerships with multiple, often non-traditional sectors, further improving community-based support, stewardship and compliance with marine protected areas (MPAs) and other regulations.

Regulatory changes

Recent efforts across the US Caribbean led by the National Marine Fisheries Service (NMFS) resulted in the designation of Elkhorn coral (*Acropora palmata*) and Staghorn coral (*A. cervicornis*) as threatened species in 2006 under the Endangered Species Act (ESA), establishing very strict regulations regarding the conservation of both species. Critical habitats were designated in 2008, but species recovery plans have not been produced yet for either species. NMFS is now considering reclassifying both species as endangered, as well as listing Cactus coral (*Mycetophyllia lamarckiana*), Pillar coral (*Dendrogyra cylindrus*), and Star corals (*Montastraea annularis*, *M. faveolata*, *M. franksi*), which were recently reclassified under genus *Orbicella* (Budd *et al*. 2012). If these species are eventually listed as endangered, there would be a completely new set of highly restrictive rules related to research involving any of these species, including coral farming and reef rehabilitation activities.

Figure 3. Coral outplanting has resulted in a rapid increase in the abundance of recruits of commercially important fish families, such as Haemulidae, Lutjanidae and Serranidae. It has also fostered increasing densities of juveniles of important herbivore guilds, including Scaridae and Acanthuridae.

Endangered corals listing: Achieving coral protection or roadblocks to community-based engagement?

Preparing to conduct research on coral species potentially designated as endangered under ESA has already been deemed as significantly burdensome to the scientific community as a result of the extra administrative steps that will be required to apply for research permits (Weijerman *et al*. 2014). On this sense, NMFS initiated during 2013 a new process requiring all coral farmers across the U.S. Caribbean to request a new permit under section 10 of ESA for conducting coral farming or reef rehabilitation and/or restoration activities with acroporids or any of the candidate species for listing, even though no corals have been listed as endangered yet. This will involve an onerous, time-consuming, tedious, complex, and highly technical and bureaucratic permit application process. NMFS also requires applicants to provide evidence of their academic background and peer-reviewed publications history, which raise the concern that most community-based coral farmers might get automatically excluded from even applying for a permit by failing to comply with strict academic credentials. To complicate the situation, the U.S. Navy Corps of Engineers is now threatening to take legal action against coral farmers across the U.S. Caribbean by claiming that low-tech coral farming units are not in compliance with existing regulations of permitted uses in U.S. navigable waters. This would further represent an extra burden for small community-based coral farmers, besides rendering them legally liable for any incident with coral farms under their custody, potentially resulting in overwhelming expenses in insurance. At the local level in Puerto Rico, there are also new efforts by the PR Department of Natural and Environmental Resources (PRDNER) to restrict State permits to applicants which can show evidence of already available funding to conduct projects. The catch-22 here is that Federal funding agencies often require evidence of *a priori* approved permits from regulatory agencies to conduct coral farming and transplanting activities before allocating funds. Therefore, the proposed changes in the qualifying regulations at the Federal and State level (in Puerto Rico) could have the long-term effect of becoming major roadblocks to community-based initiatives and participation in coral farming and reef rehabilitation activities, in spite of their proven success.

If the proposed coral species are listed as endangered under ESA, it may certainly represent the highest level of Federal legal protection within the U.S. Caribbean for any declining species. Nonetheless, it may also represent a major step backwards for community-based participation and integration in managing natural resources as new legal requirements will make this task nearly impossible to undertake for most non-

scientific stakeholders. Community-based coral farming and reef rehabilitation initiatives in Puerto Rico have already been of significant and novel value to the conservation and rehabilitation of U.S. coral reef ecosystems (Fig. 4). Benefits include providing baseline guidance to reef managers and decision-makers regarding the ecosystem-level benefits of coral farming and reef rehabilitation efforts, and providing critical quantitative baseline information to parameterize coral population models to guide future Acroporid corals restocking, which will provide guidance for testing future rehabilitation efforts across other Caribbean reefs. These efforts have also resulted in integrating local stakeholders into successful management practices, improving local stewardship and support, building stronger trust, reviewing and amending existing MPA management plans, and developing a set of minimum guidelines to drive future management-oriented decision-making processes, including reef rehabilitation efforts to maximize their ecosystem-level impacts.

Figure 4. Twelve-year old outplanted colony of ESA candidate Star coral *Orbicella faveolata* in Culebra Island, Puerto Rico. Under proposed new rules across the US Caribbean successful community-based coral propagation initiatives such as this would become very difficult to achieve due to burdensome permit application procedures.

A call for precaution

Community-based low-tech coral aquaculture and reef rehabilitation approaches in Puerto Rico have proven to be successful, reliable and highly cost-effective tools to conserve and restore Staghorn coral populations with minimum intervention and maintenance, and should not be deemed as minimal. These tasks have always been carried out in support of State and Federal management efforts to conserve and restore local coral reefs, and have been recognized by the U.S. Coral Reef Task Force. The *Community-Based Coral Aquaculture and Reef Rehabilitation Program* has been a successful model to empower wider Caribbean community stakeholders in basic coral reef conservation and coral transplanting methods, with major implications in helping base communities to engage in conservation-oriented coral reef management and to adapt and manage climate change impacts on their "backyard" coral reef ecosystems.

Hands-on and behavior-modifying, transformative education, associated with these activities, is a crucial product of base community-academia integration and their active participation, improving local stewardship. Adaptive responses in low-tech coral farming and reef restoration will be critical to keep up with climate change in the near future. They could also be used to promote the rehabilitation of reef ecosystem's resilience, biodiversity, ecological functions, and services, as well as their socio-economic, ecological and environmental benefits. This is a model project of successful integration of academia, NGOs, fisher communities, base communities and stakeholders that can be applied throughout the wider Caribbean region and elsewhere. Such collaborations will be important in a time of economic constraints across developing small island nations. But stronger and successful trust-building, and stakeholder participation and integration can only be achieved through transparent, participatory processes and not through legal actions aimed at perpetuating unpopular, often non-functional, top-down management approaches which might result in a significantly limited community-based participation. Such top-down approaches may cause problems and potential rejection by small-island based communities which have shown a long tradition of strong engagement in multiple coral reef conservation efforts, and should be carefully reviewed and reconsidered before a final decision is made.

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REEF ENCOUNTER
The News Journal of the International Society for Reef Studies
Reef Perspectives: Parrotfishes and Wrasses

PARROTFISHES ARE NOT WRASSES

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Since the discovery of the importance of DNA to the study of plant and animal evolution, much emphasis has often been placed on the genetic aspects in classification, at the expense of observable morphological characteristics. That the parrotfish family Scaridae is being subsumed into the Labridae by some ichthyologists is a prime example.

The parrotfish has been known as a unique fish since Aristotle wrote, "All fishes are saw-toothed excepting the scarus" and "Of all fishes the so-called scarus, or parrot, is the only one known to chew the cud like a quadruped". The first published images of parrotfishes may be found in Louis Renard's 1719 collection of fanciful paintings of fishes and large crustaceans from the Molucca Islands and Australia. Three of the paintings were identified as *Scarus* sp. (Pietsch, 1995), but none can be linked to any species of parrotfish we know today.

The first parrotfish to be given a valid scientific name was *Sparisoma cretense,* described by Linnaeus in his *Systema Naturae* (1758), then placed in the large genus *Labrus.* It is known from the Mediterranean Sea (type locality off Crete) to Senegal, and is unusual in the predominantly red female being more colorful than the male.

Six species of parrotfishes were described in 1775 by Peter Forsskål, the Swedish naturalist of a six-man Danish expedition to the Red Sea (1761-1767). The fish specimens he collected were prepared as dried skins. Many were damaged in transit back to Europe, and some were lost. One named *Scarus psittacus* (the species name means parrot in Latin) was among those lost. Only one man of the expedition made it back to Denmark, the cartographer Carsten Niebuhr (Forsskål died of malaria in Yemen) who prepared Forsskål's notes for publication.

Parrotfishes have proven difficult to classify because they are so similar in morphology and because they change so much in color from juvenile to adult, and for most species between what is termed the initial phase (can be male or female in many species, only female in others) to the more colorful terminal male. Figures 1 and 2 are underwater photographs of the initial phase and terminal male of *Scarus psittacus*.

Rafinesque (1810) was the first to classify the parrotfishes as a distinct family. This arrangement was recognized by Bleeker (1859), and many publications over the years, both scientific and popular, continued to regard the Scaridae as a family. Noteworthy is the detailed morphological study of by Bellwood (1994) who wrote, "… the monophyly of the Scaridae is strongly supported by a wide range of

Figure 1. *Scarus psittacus*, initial phase, Gulf of Aqaba, Red Sea (J.E. Randall).

Figure 2. *Scarus psittacus*, terminal male, with *Labroides dimidiatus*, Maldive Islands (J.E. Randall).

Figure 3. Neotype of *Scarus psittacus*, Jeddah, Red Sea (J.E. Randall).

derived character states, many of which are unique and unreversed."

Schultz (1958) attempted a revision of the Scaridae, recognizing 79 species. He considered *Scarus psittacus* to be a synonym of *Scarus harid* Forsskål. Smith (1959) insisted that Schultz was wrong, that *psittacus* must be *Scarus ghobban* Forsskål. Their acrimonious exchange in the scientific literature on the identity of *Scarus psittacus* is amusing, given that both were wrong. Forsskal's descriptions, though brief, were precise. His *Scarus psittacus* is a small species that came from Jeddah, Saudi Arabia. The first author collected a terminal male specimen from off Jeddah, photographed it (Fig. 3), and described it as a neotype (Randall and Ormond 1978).

A total of 394 new species names have been proposed for the Scaridae, of which only 88 were regarded as valid in a checklist by Parenti and Randall (2000). Eleven additional valid species were reported by the same authors in an updated checklist (2011).

There has never been a question about the close relationship of the wrasses (Labridae) and the parrotfishes (Scaridae). There is a controversy, however, whether the two should be regarded as one family, the Labridae, or whether the parrotfishes are deserving of retaining family status. We point out that the close relationship of the families is recognized by the suborder Labroidei that includes the Labridae and Scaridae, along with the Odacidae, Embiotodicae, Pomacentridae, and Cichlidae.

In a review of the three-volume *Reef Fishes of the East Indies* by Allen and Erdmann (2012), Rocha (2013) criticized the authors for classifying the parrotfishes as a family, instead of following Westneat & Alfaro (2005) and Choat et al. (2012) by grouping them with the wrasse family Labridae. We take strong exception to this. Wrasses are carnivores.

By contrast, the parrotfishes are primarily herbivorous. After the plant-feeding fishes (such as the surgeonfishes, sea chubs, and rabbitfishes) have browsed and grazed the benthic algae of reefs, there is still a stubble of algae and associated small animal life on the surface. The parrotfishes have evolved to exploit this remaining source of nutrition. With their strong dental plates and powerful jaws, they scrape the reef surface, biting into the substratum when it is limestone (and some species bite into live coral as well, hence get both the animal tissue of the coral and its zooxanthellae). They then grind these fragments with their unique pharyngeal dentition to fine particles, thus making the algae (and the small animal and microbial life) more digestible in their extremely long intestine (parrotfishes have no stomach). Through this feeding action they are responsible for the creation of much of the sand one sees around coral reefs.

As to whether the Scaridae should retain family status, Dr. Ben Diggles (pers. comm.) wrote: "Mabuchi *et al.* (2004: *J. Mol. Evol*. 59: 287-297) used molecular clock techniques to suggest the shared common ancestor between Labridae and Scaridae existed around 42 million years ago, a deep enough genetic divide, one would think, to argue for the status quo."

Another important point to consider is nomenclatural stability. Parrotfishes have been a family for 213 years. Laymen with an interest in marine fishes of tropical and subtropical seas know the parrotfishes as a family. They would certainly have reason to be puzzled if ichthyologists reclassify them as wrasses.

With the recent description of the parrotfish *Sparisoma choati* by Rocha et al. (2012) from the eastern Atlantic, the Scaridae now has 100 valid species. The Labridae, which has increased in the last two years by 13 species, and been reduced by one as a synonym, now consists of 516 species. Surely both taxa are also large enough to warrant family status?

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POETRY CORNER

The Adaptive Bleaching Hypothesis in Rhyme

John Ware; email jware@erols.com (with apologies to Bob Buddemeier and Daphne Fautin)

An elderly coral was teaching
The younger corals 'bout bleaching:
A word to the wise:
As temperatures rise,
Change the zooxs that you're planning on hosting!

Let me be just a bit more specific,
Here's advice that you'll all find terrific:
Rid yourselves of Clade C
And acquire Clade D
And then you can all be prolific!

So to Scleractinian corals a warning:
'Bout the phenomenon that's called Global Warming!
As pCO^2 levels increase,
Aragonite formation will cease,
Making you more susceptible to storming.

But have Daphne and Bob got bad rap?
Acclimatize, acclimate, or adapt!!
Is the Adaptive Bleaching Hypothesis
To science a very antithesis,
Or actually and really a fact?

For the answer we must turn to the zooxs:
Check the DNA of those little brown folks,
Who inhabit the corals
On all reefs and atolls,
And make us the butt of their jokes.

Historical note: The original of this rhyme was presented at the 2005 GEF Targeted Research Group on Coral Bleaching meeting in Puerto Morelos, Mexico, when to my surprise I came into the conference room one morning and found it on the screen! I believe a version of it was published in Reef Encounter in 2008 (JW)

REEF CURRENTS

General articles and overviews of reef science and management

Unlocking the secrets of Hawaii's deep-water photosynthetic corals

Samuel E. Kahng

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Undisputed heavyweight champs (in shallow-water)

In nature, competition can be fierce. In the absence of major disturbance, the species with superior physiology and capabilities eventually dominate in terms of abundance. For example, on Hawaii's coral reefs five species of reef-building corals (*Porites lobata*, *Porites compressa*, *Montipora capitata*, *Montipora patula* and *Pocillopora meandrina*) account for over 90% of the coral cover in shallow waters. All reef-building corals secrete a calcium carbonate skeleton and share a common strategy for life. They harbor photosynthetic microalgae (zooxanthellae) in their tissue which supply them with food to supplement what their polyp tentacles catch in the clear, nutrient- poor waters surrounding Hawaii. Therefore, all reef- building corals are capable of both autotrophy (synthesizing their own food) and heterotrophy (eating other organisms).

Reef-building corals (also called zooxanthellate corals) depend on sunlight to fuel their growth and cannot survive indefinitely in darkness. With increasing depth in the ocean, light becomes weaker and eventually limits the depth at which obligate photosynthetic organisms can survive. In the dark depths, "azooxanthellate" corals (and other suspension feeding animals) which lack photosynthetic symbionts live by catching/extracting plankton from the water. In Hawaii, these obligate heterotrophs grow more slowly than photosynthetic organisms and often cannot compete with them for space in the shallower, sunlit habitats.

Life on the edge of darkness

Due to Hawaii's remarkably clear waters, sunlight penetrates to great depths. Expeditions using the Hawaii Undersea Research Laboratory's (HURL) *Pisces IV/V* submersibles have discovered light-dependent corals forming dense, thriving "mesophotic" communities well below normal SCUBA diving depths extending to dimly lit reefs at 40-150 m. At Johnston Atoll, obligate zooxanthellate coral colonies have been observed growing *in situ* at 165 m. Interestingly, these deep-water coral communities are dominated by corals of the zooxanthellate genus *Leptoseris.* At these mesophotic depths, the dominant shallow-water coral genera (i.e., *Porites, Montipora,* and *Pocillopora*) become rare, and none have yet to be observed growing anywhere in the world below 100 m. In fact, *Leptoseris* corals which are cryptic and rare in shallow waters appear to dominate the coral community in the lower photic zone throughout the Pacific and Indian Oceans. For these zooxanthellate corals, the wholesale change in the dominant group at depth suggests special evolutionary adaptation to low light.

Deep-water lightweight dethrones the heavyweight champ, but how?

Corals belonging to the genus *Porites* are the most abundant shallow-water corals in Hawaii and account for >50% of all coral cover across the archipelago. However, their replacement by corals of the genus *Leptoseris* with increasing depth as the dominant (and eventually the only) zooxanthellate coral taxon begs the question: what can *Leptoseris*

do that *Porites* and other shallow-water coral genera cannot? Unlike their heavy shallow-water cousins, *Leptoseris* corals form dark, flat delicate plates which maximize their exposure to downwelling light (Figure 1). However, many other coral taxa are able to acclimate to low light by forming similar plate-like shapes and increasing their photosynthetic pigments to capture more ambient light. So why can't *Porites*, the undisputed shallow-water heavyweight champs, compete with lightweight *Leptoseris* at depth?

Figure 1. A large colony of the dominant shallow-water reef building coral *Porites lobata* (left) growing at 2 m in Waimanalo and a colony of the dominant deep-water plate coral *Leptoseris hawaiiensis* growing at 95 m in the Au'au Channel between the islands of Maui and Lanai.

To investigate this twilight zone mystery, the ecophysiology (physiological adaptation to environment conditions) of the dominant shallow-water corals (*Porites*) were compared with the dominant deep-water corals (*Leptoseris*). The results were recently published in Marine Ecology Progress Series (http://www.int-res.com/abstracts/meps/v455/p65-77/). Below is a summary of the intriguing findings.

Optical illusion or deep-water riddle?

Measuring the light reflected by live coral colonies confirmed that the visually darker, deep-water *Leptoseris* colonies (collected from 68 to 113m) consistently absorbed more light than shallow-water *Porites* colonies (collected from 2 to-15 m). However, when the concentrations of light-absorbing pigments were measured, the results were completely unexpected. These corals share the same types of photosynthetic pigments, but *Porites* consistently exhibited higher concentrations of photosynthetic pigments (per unit area) than *Leptoseris*! Given the identical color, chemical composition, and mineralogy of their skeletons, these results are paradoxical. How can one coral be darker and absorb more light with less pigment?

> ***Leptoseris* paradox**: If you are a painter with only one type of paint and there are two walls made from the exact same material, how do you make one wall darker than the other while using less paint?

It's all about the wall and not the paint

The highly reflective nature of white skeletons plays an important role in increasing the photosynthetic efficiency of corals versus plants. When incident light passes through plant or animal tissue, the amount of light absorbed depends on the concentration of photosynthetic pigments in the tissue. In the case of a plant leaf, some of the light may escape through the bottom of the leaf. In the case of the coral, light does not escape through the bottom of the

coral but is reflected by the skeleton back through the coral tissue allowing the photosynthetic pigments a second chance to absorb the light. While both plants and corals living in the shade often increase their photosynthetic pigment concentrations to maximize light absorption, such a strategy consumes energy/resources with diminishing returns on this incremental investment in pigment concentration. In addition to reflecting light, coral skeletons scatter the light at multiple angles, thereby increasing the path length that a photon of light must travel through the coral tissue and increasing the likelihood of light-pigment interaction. Prior studies have shown that skeletons enable corals to be 2-6 times more efficient at using light for photosynthesis than plants.

Optical geometry drives efficiency

To solve the *Leptoseris* paradox, coral skeletons were analyzed using a scanning electron microscope and measured optically using a spectrometer. Close examination of the optical micro-geometry of *Leptoseris* skeletons reveals ordered rows of concave cavities which trap light in reflection chambers thereby increasing the probability of light absorption despite having lower pigment concentrations. In contrast the optical micro-geometry of *Porites* lacks a systematic architecture for consistently trapping light thereby resulting in a lower efficiency of light absorption despite having higher pigment concentrations.

To confirm the role of skeletal optical geometry in enhancing light harvesting efficiency, coral skeletons with pigments and tissue chemically removed were measured for spectral reflectance properties. Despite having identical chemical compositions, the tops of *Leptoseris* skeletons consistently absorb more light than the tops of *Porites* skeletons due to their respective micro-morphologies. This effect is caused by more light-skeleton interactions (internal reflections) in *Leptoseris* than in *Porites*. The tops of *Leptoseris* skeletons also always absorbed more light than their featureless undersides confirming that the surface micro-architecture is responsible for the optical effect. This strategy is analogous to the architecture of sound absorbing panels which are designed to trap sound waves within reflection chambers to increase probability of absorption.

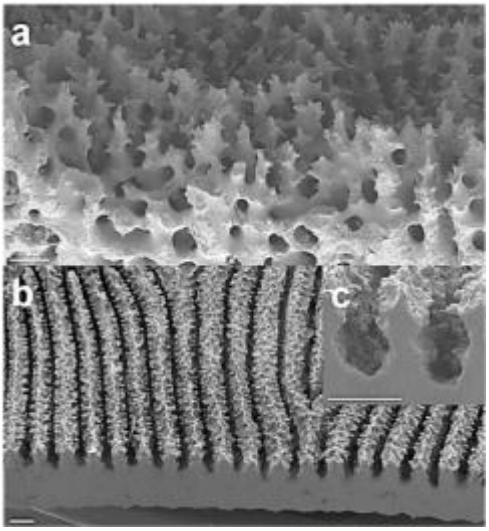

Figure 2. Scanning electron micrographs of (**a**) *Porites* and (**b** & **c**) *Leptoseris* skeletons. Cross section of *Porites* reveals a porous skeleton with an irregular geometry, whereas cross section of *Leptoseris* skeleton reveals parallel costae forming deep concave valleys. All scale bars = 200 µm.

In the energy limited realm of the lower photic zone, energy efficiency reigns supreme. While increasing pigment concentrations may increase ambient light absorption, it represents an expensive investment to maintain with diminishing returns with increasing depth. Greater light harvesting efficiency enables *Leptoseris* to thrive uncontested at deeper depths while *Porites*, the energy guzzling bullies in shallow-water, are restricted to areas where light is plentiful.

Efficiency vs. durability

Given the morphological diversity of reef-building corals, why haven't other corals mastered the art of using their skeletons to capture light as efficiently as *Leptoseris*? The answer may lie in the need to specialize within a given habitat. In shallow water, coral skeletons must be robust to withstand strong hydrodynamic forces including storms. Also, competition for space and light is fierce so corals must grow upward as well as outward. The micro-scale architecture required to support these functions may be incompatible with those exhibited by *Leptoseris.* While enabling superior light harvesting, the micro-scale surface architecture of *Leptoseris* is delicate and susceptible to mechanical damage. Most deep-water *Leptoseris* colonies appear to grow radially outward suggesting that their specialized micro-scale surface architecture may be less compatible or even incompatible with upward growth.

However, *Leptoseris* in deep water is protected from wave stress, and competition for space with other photosynthetic organisms is virtually absent. The divergent roles of the coral skeleton may help explain the dichotomy between *Porites* and *Leptoseris* as masters of separate realms despite their fundamental similarities as zooxanthellate corals.

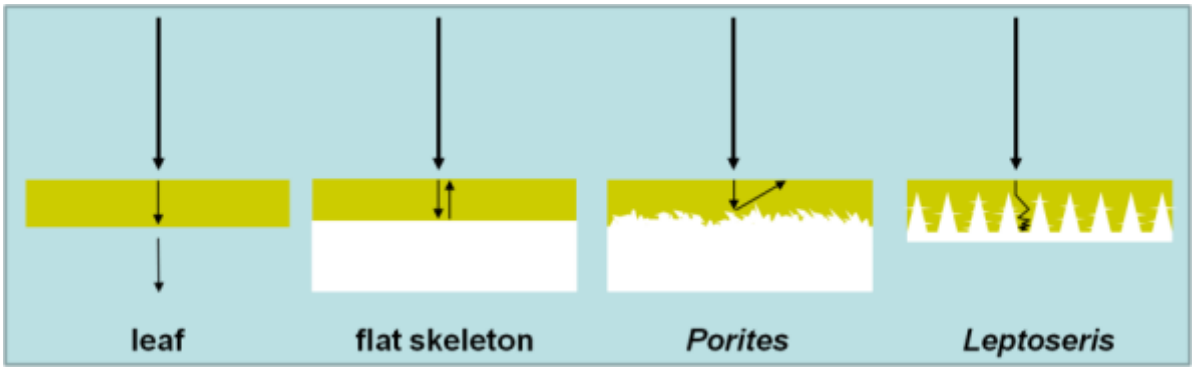

Figure 3. Diagram showing hypothetical interaction of light photons (arrows) passing through tissue (shown in yellow) and interacting with coral skeletons (shown in white). In the case of a plant leaf (far left), light passes through the tissue only once and any light not absorbed by pigments escapes through the bottom of the leaf. In the case of a coral skeleton (second from left), light not absorbed during its initial pass through the tissue can be reflected back through the tissue. Due to the surface roughness of coral skeletons (second from right), the path length of a light photon through the tissue may increase via scattering at low angles. In the case of *Leptoseris* (far right), the path length of a light photon may involve multiple scatterings between parallel ridges (called septocostae), thereby increasing the probability of photon absorption by pigments within the coral tissue.

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Fish, bold on acid

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If only fish could 'just say no'. Acidification of seawater makes the most important fisheries species on the Great Barrier Reef in Australia live dangerously. Juvenile coral trout that experience higher than normal levels of acidity venture from shelter and become bold to the point they are attracted to the odour of potential predators, Professor Philip Munday of James Cook University, Queensland, and colleagues have found.

Results of the first comprehensive study of the effects of climate change on a commercially important tropical reef fish show that near-future ocean CO_2 levels, of 700 and 960 microatmospheres, may compromise coral trout populations. "We found that the physiological mechanisms that fish use to control their blood and tissue pH, when exposed to higher CO_2 levels, can interfere with the function of a major neurotransmitter receptor in the brain," says Munday.

Fish can regulate ionic changes in blood to prevent acidosis, but this itself can alter the function of GABA-A neuroreceptors. Our colleague, Goran Nilsson from the University of Oslo, was the first person to discover the link between neuroreceptor function and all the abnormal behaviours we have reported. We predict that rising CO_2 levels could cause sensory and behavioural impairment in a wide range of marine species, especially those that tightly control their acid–base balance through regulatory changes in bicarbonate and chlorine levels. Carbon dioxide levels used in the study are within the range of representative concentration pathway trajectories adopted by the International Panel on Climate Change for 2100 and just beyond.

Interestingly, individuals varied in their response to predator odour at 700 µatm, which might indicate some potential for adaptation. However, it is not known if this variation has a genetic basis in coral trout, or if there is sufficient time for future generations to adapt to the rapid change in carbon dioxide levels. If adaptation cannot keep pace with the speed at which climate change occurs, long-term sustainability of wild harvests of coral trout will be undermined and aquaculture may prove critical to meet national and international demands. The United States National Oceanic and Atmospheric Administration says that by the end of this century, based on business as usual emission scenarios, the acidity of surface waters of the ocean could be 150 percent higher - a pH the oceans haven't seen in over 20 million years.

If these predictions come to pass, is the future of fisheries in a glass bowl?

Coral Trout inside a respirometer. *Photo by Vanessa Messmer*

Smithsonian Fish ID Guide Apps:

Digital identification guides to two regional neotropical shore-fish faunas.

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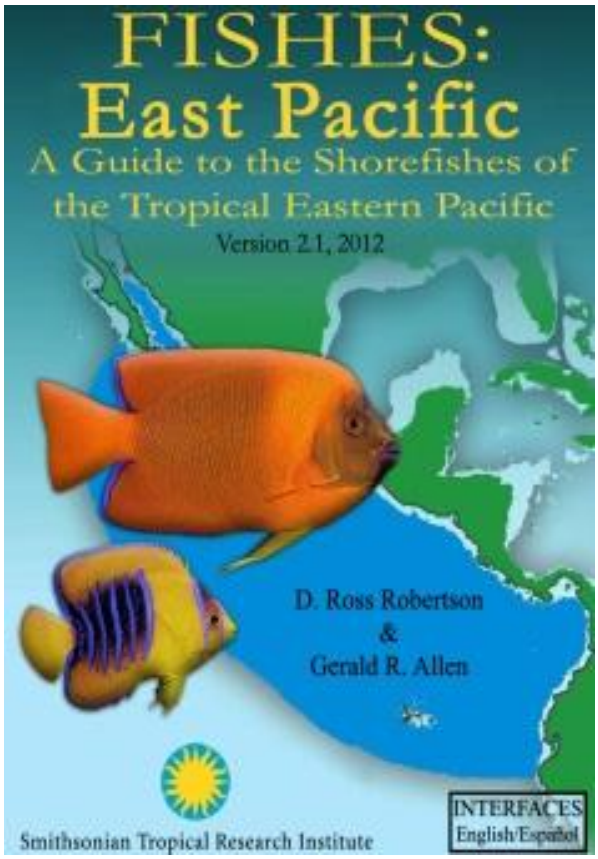
History



In 1990, when Gerry Allen and I first began fieldwork to obtain material for a printed guide to the nearshore fishes found in the Tropical Eastern Pacific (TEP), the only guide available for such fishes was Thomson et al's 1979 book on the *Reef Fishes of the Sea of Cortez*. This provided good coverage for widespread reef fishes, but did not include either the many species of reef fishes restricted to the southern, more tropical parts of the region, or more than a handful of species in other major ecological groups, such as pelagic species or those that live on sand and mud bottoms. The English edition of our book, *Fishes of the Tropical Eastern Pacific*, which provided coverage of a broad range of ecological and taxonomic groups of shore-fishes, was published in 1994, and a Spanish edition of that followed in 1998. This covered almost 700 species and included about 650 images. At about that time the power of digital media to incorporate very large amounts of information, particularly images, and do so cheaply and in a searchable manner was becoming obvious. This stimulated me to obtain funding to produce a bilingual CD-ROM adaptation of the books. This was released in 2002, and an expanded DVD-ROM version in 2006. This digital database was then used to construct a website version, which expanded to cover 1100 species. This site opened in 2008. Websites only work when the user has an internet connection, and at that time such connections were poor in many parts of central America. As mobile devices came into common usage the potential for them to offer completely portable (internet independent) guides to regional faunas became obvious. That stimulated me to obtain grants to first produce a iOS mobile app based on the information in the TEP website, and then, in 2004, begin fieldwork for an equivalent iOS mobile app for the fishes of the Greater Caribbean, the sister biogeographic region to the Tropical Eastern Pacific (TEP). **Fishes East Pacific:** Version 1 iPhone app was released in January 2012, and an iPad version in October 2012. **Fishes Greater Caribbean:** Version 1 iPhone app was also released in October 2012.

Plans for future editions

Future iterations of both apps will include (i) more species (newly described shallow species not already in the database; deeper members of already included shallow taxa, to complete coverage of the taxon; deep taxa for which photographs and other information have become available); (ii) expanded search capability (e.g. the addition of various "habitat types" to the criteria available in the combination search); and (iii) a "Diver Guide", that will give users the option of working with either the entire fauna or a subset of species likely to be encountered by snorkelers and Scuba divers on and near reefs.

Websites and portable versions for other platforms: The TEP app will be linked to an updated and reconstructed version of its 2008 website and a website created for the Caribbean app. It is intended to use the content of both those websites to then feed a set of apps capable of being used on any major platform and device (Windows, Android, iOS; mobiles, MAC, PCs). This will give users the option of using content online or downloading a portable version for use on various different devices independently of an internet connection.

It may be helpful here to potential users to give an overview of the apps' principal features.

App Features

Bilingual Interfaces: Both apps have complete English and Spanish language interfaces. The interface choice is determined by the language set by the user in the device's preferences.

Tools for indentification: Both Apps contains tools to identify and record information about species of shore-fishes from the Greater Caribbean and Tropical Eastern Pacific. Those include all shallow-living (<100m depth) occurring in littoral and neritic habitats in those regions. Version 1 of the Pacific app covers 1,297 species from 140 families and version 1 of the Caribbean app 1, 599 species from 169 families. Images of fish are a key ingredient of any identification guide, and electronic media can accommodate huge numbers of them at zero incremental cost. The Pacific app contains >3,500 images, and the Caribbean app >5,500 images, the great majority of them color photographs of live or freshly collected fish. While many images are photographs taken by the App authors, well over half those used in each app came from more than 500 photographers and other sources, the vast majority of whom donated use of their images for these non-commercial apps. Ownership of each image is acknowledged, with an email or website contact.

Species Pages: Each species page includes 1 or more images of the species, a key-features box, a description box, and a map of the species regional distribution. The description box contains a description of the form and color of the species (highlighted at 3 levels to indicate the relative importance of different features), and notes on its size, habitat, depth range, and global geographic distribution. The material in the key-features box on each page aims to help the user distinguish the focal species from other, look-alike similar species. Buttons under the species main image include: Similar-species, which links to a page that displays the main image + key features and range-map of the focal species plus those for other designated similar species; Family**,** which connects to a page showing an image and description of characteristics of the family to which that species belongs; Notes, which connects to any list in the notebook module and allows the user to record information about the focal species in that list; Glossary, which links to a searchable glossary of scientific terms; and Red List, which displays the *IUCN Red List* extinction-risk status of the selected species. The **s**pecies range maps in each app were derived from information based on the author's (and co-workers') collections and observations, records from museum collections and the scientific literature, and photographic records from many sources. Information in each species pages (a fish's scientific and common names; its range map; its shape, color pattern and colors; and which species it is most similar to) is used to power the search module and the notebook module of each App.

iPad interface enhancements: The larger iPad screen allows the addition of two features not available in the small-screen iphone version: Glossary Illustrations – drawings, with body features labeled, of the body of a bony fish, a shark, and a ray. High definition species range maps – a full-screen high definition map, with dots indicating sites where a species has been recorded - can be accessed from its small species-page map.

Browse and search modules

The Browse module enables the user to browse among lists of species and families using an alphabetic scroller or by entering a name (species - first or last common name, genus + species of the scientific name; family - common and

scientific names). Various options are available. Name ordering: order of the display of first and last common names and scientific names in both lists can be set by the user. Species list: Browse through a list of all species, each with a thumbnail image, with names arranged alphabetically. Each name connects to that species' page. Family list: Browse among all families with names arranged alphabetically. Each family name links to a page that displays a list of its member species.

The Search module aims to help the user Identify an unknown species using a Combination Search: The user selects and combines any of the following criteria in any order: a name (common - generic; scientific - genus or family); location: choose the local fauna from one or more parts of a regional map (14 parts of the Tropical Eastern Pacific, 19 parts of the Greater Caribbean); and select one or more of fish shape (s), color pattern(s), and color(s). As different selections are added, the gradually narrowing number of species-matches is indicated, and leads to a list of potential species (with thumbnails) connected to their species pages.

Notebook module

This further module allows the user to review recently visited species pages and to construct and store species-lists that include data relating to the list itself and data about each species in a list, to organize those lists in folders, and to export lists. Thus the recently visited species pages enable the user to **r**eview the 15 most recently accessed, automatically stored species pages.

List maker: Using the "List Maker", species-lists are stored in a one or more user-created folders. After creating a folder to store it, the user can construct a new list either from the bottom up, by adding names to an empty list from the master species-list in this module, or from the top down, by copying an existing list. A copy can be made of either a model list (a list of species known from one of the named parts of the regional map used by the search module) or a previously-constructed list made by the user and stored in the App's database. A newly copied list provides the user with an "empty" list of species names without any species-data or list-data.

Manage species names in a list: Species can be added in this module to any list from a scrolling master-list that contains all species in the database. When adding species to an active list (one that already contains names) the scrolling addable-species list displays only species names NOT currently in that particular list. Species can also be added to a list from a species page, using the "notes" button on that page. Species are deleted from a list with a horizontal finger swipe.

Manage list-data and species-data of a list: List-data include a list-name, latitude/longitude, time and date, and user notes about the list. Latitude and longitude can be entered manually or from the device's GPS. Latitude and longitude are in decimal degrees. Display of a thumbnail image associated with each name in a list can be turned on/off. The user can select which name(s) (scientific &/or common) to display in a list. Species-data include: flagging a species to indicate its active presence on a list, and adding text and a numeric data in different boxes. Flagging-status and numeric data for a species are displayed next to its name on the scrolling active list. Species-data can be added in this module or via the "notes" button on a species page. A species is automatically flagged when it is either added to a list using the "notes" button on a species page, or text and numeric data are added to it in the notebook module. A counter indicates the total number of species on a list and the number of those that have data of one sort or another (flagging, numbers, text). Species pages of list-members can be accessed from a list. Finally you can export any stored list by email. An exported list includes the list name and list-data, plus its species names and their species-data (without species images).

Finding and downloading the apps:
Search in iTunes App Store for "Fishes: East Pacific" and "Fishes: Greater Caribbean" or use these direct links:
Caribbean App: https://itunes.apple.com/us/app/fishes-greater-caribbean/id570048678?mt=8
Pacific App: https://itunes.apple.com/us/app/fishes-east-pacific/id494644648?mt=8

Asuncion Sia

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When Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste (CT6) came together in 2007 to form the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF), they agreed to pursue multilateral and coordinated actions to safeguard the marine and coastal biological resources of the Coral Triangle. In the reckoning of the environmental community, the move was long overdue – the Coral Triangle, the global epicenter of marine biodiversity, sits at a growth hub where rapidly expanding populations, economies and trade are putting vital coastal and marine resources under severe and increasing strain, and regional cooperation to protect these resources has long been regarded as an urgent need. This did not make CTI-CFF any less bold or challenging, and to those tasked to help forge regional cooperation, one of its many challenges lay in putting together the information needed to support management planning and decision-making at a regional level. Decades' worth of data on fisheries, biodiversity, natural resources and socioeconomics had been collected by researchers and managers across the Coral Triangle, but these data needed to be aggregated at a regional scale.

The CT Atlas, an online GIS database on the Coral Triangle, was designed to respond to this need. By and in itself, the Atlas is a success story of cooperation that spans the globe. It was developed over the last four years by a team of experts working out of their offices in the U.S., Malaysia, Indonesia and Australia. Annick Cros, who coordinated the program from The Nature Conservancy (TNC) in Hawaii, conceived the idea with Nate Peterson, a colleague based in Brisbane, Australia. But the inspiration came from another part of the world, Cros relates. "Nate and I were talking with a colleague from the Caribbean who told us about his project to create one database for a number of countries. We had been working on trying to get conservation data on the Coral Triangle for TNC, and we saw that this was exactly what we needed. We took it from there and started looking for funding and the right partners to work with."

WorldFish Center, a research organization based in Penang, Malaysia that built and manages an online GIS for coral reefs called Reefbase (reefbase.org), was the obvious choice to be a key partner to TNC for the CT Atlas. In addition, three other international NGOs were eventually engaged in the project, namely, World Wildlife Fund (WWF), Wildlife Conservation Society (WCS) and the International Union for Conservation of Nature (IUCN). Supported by the U.S. Government through the 5-year (2009-2013) US CTI Support Program (USCTI) and working closely with WorldFish, TNC led and coordinated these partners' contributions to the Atlas.

Even with all five NGOs involved, however, gathering the all-important data about the Coral Triangle has been a struggle. To get things moving, the team initially built the database using data from the numerous NGOs working on marine protected areas (MPAs) in the region, and in the frenzy of the first several months of data gathering, the focus, as WorldFish GIS analyst Teoh Shwu Jiau puts it, "was on quantity rather than quality."

Teoh is part of the CT Atlas team at WorldFish that also included at various periods during the past four years Reefbase team leader Moi Kim Tan, Web development specialist Stanley Tan, GIS experts Nurulhuda Ahmad Fatan and Reuben Venegas, and their advisor, Senior Scientist Douglas Beare. Together with Cros, Peterson, TNC advisor for the CT Atlas Alan White, Washington DC-based GIS analyst for WWF-US Charles Huang, Jakarta-based GIS analyst for WWF-Indonesia Christian Handayani, and TNC-Indonesia GIS expert Wen Wen, they made up the core team that developed the CT Atlas database and its Web-based user interface. They were an apparently disparate group separated by physical distance, but it did not take long for the team to find their feet and focus. Soon enough, data quality improved, giving the Atlas a solid reputation, at least among researchers and students (so far its biggest group of users), for having the most up-to-date MPA database on the Coral Triangle.

Talking sustainability: members of the CT Atlas team and representatives from partner organisations met in Penang over 14-16th May 2013 to map out sustainability plans for the atlas. Photo by S.L.Tan (Worldfish).

Key to the Atlas's future success as a management planning tool for CTI-CFF is the full engagement of the CT6, its primary target users. Concerned about issues of data ownership and security, the countries were slow at first to buy into the idea of a regional database, especially one that was open access and hosted by a third party website. Hendra Yusran Siry, secretary for external affairs and coordination of the CTI-CFF Interim Regional Secretariat, says data ownership and security have always been primary considerations for the countries. It is important for the countries that they have ownership of the CT Atlas and that safeguards are in place to ensure data integrity, he explains.

Key to the Atlas's future success as a management planning tool for CTI-CFF is the full engagement of the CT6, its primary target users.

The team has responded by building into the system appropriate security features and working out with each country specific terms of data ownership and sharing. In turn, the countries have collectively reciprocated in a way that could expand the functions of the CT Atlas: At their meeting last November 2012, the CTI-CFF Council of Senior Officials formally recognized the Atlas as integral to the implementation of the CTI-CFF monitoring and evaluation (M&E) system. This, WorldFish's Beare predicts, "will put the CT Atlas ahead of the game in indicator mapping."

It certainly adds a new dimension to the story that the Atlas is already telling about the Coral Triangle. Says Cros, "We have added layers that have been officially provided or validated by the CT6 governments, and what these tell us is that it is not just the NGOs that support conservation in the region, but the governments as well. Also, the fact that we are able to see on the maps the boundaries of MPAs tells us a lot about the level of cooperation and trust between countries, because it shows that they are willing to share this kind of information with other countries and the public."

The fact that we are able to see on the maps the boundaries of MPAs tells us a lot about the level of cooperation and trust

The story that Cros hopes will eventually emerge is one that shows resource managers "stepping out of their countries and becoming really engaged regionally and looking at the conservation potential for the region and not just each country individually." She adds, "I hope that the maps the CT Atlas produces and the data it serves will make people understand how scaling up helps the process of conservation."

For now, with U.S. Government support winding down in the next few months, the team is focused on putting in place a strong platform for the sustainability of the CT Atlas, and again working with partners and the countries will be crucial. They have drafted a plan that calls for WorldFish to take the lead in maintaining and managing the Atlas, while recognizing that its ownership primarily resides with the CT6. To actualize the plan, WorldFish will designate a technical manager to work closely with the CTI-CFF M&E Regional Coordinator to facilitate the integration of CTI-CFF M&E information in the Atlas.

The plan has obtained a preliminary commitment of support from the Asian Development Bank (ADB) Pacific Program. The team has agreed that WorldFish will submit to ADB a proposal for funding that will help ensure the continued operation of the CT Atlas for at least the next two years. This reassures the Regional Secretariat's Siry. "Given our partners' pronouncements of support, I am confident that the Atlas will be sustained," he says. He sees challenges to promoting wide use of the Atlas, but for as long as the countries remain engaged and the Atlas team responsive to users' needs, he points out, the Atlas will stay relevant in the context of CTI-CFF, generating maps that each tells its own unique story on the Coral Triangle yet together make one visual argument for cooperation in conservation at a regional scale.

Maps in Action. CT Atlas maps are intended to make a visual argument for cooperation at a regional scale. Photo by A Sia (USCTI)

For information about the CT Atlas, please contact Shwu Jiau Teoh (S.Teoh@cgiar.org), Annick Cros (acros@tnc.org) or Alan White (alan.white@tnc.org).

REEF EDGE

Scientific letters or notes describing observations or data

A possible relationship between back-reef biomass and oxygen

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Forty years ago, at the Second ICRS on board the MV Marco Polo I gave an informal unpublished presentation in which I suggested that oxygen availability might be the principal factor determining the reef community biomass that could be sustained in back-reef areas of at least some reefs of the southern GBR. I never really followed through with that idea though it is indirectly referred to in a number of my publications. I am interested now to see what reaction I may get from today's much more knowledgeable reef science community.

At the outset, let me explain that the reefs of the Capricorn/Bunker Group at the southern end of the GBR are quite elevated and many have complete circumferences causing ponding of their lagoons at low tide. At such times the water may be standing, un-circulated, for up to several hours. In the case of One Tree Island, this level is approximately at mid-tide level such that all low tides are the same in the lagoon and the water stands for close to 5 hours. At Heron Island the level is rather lower with lagoon ponding occurring only on the lower tides in the fortnightly cycle and then standing for not much more than three hours.

In the first use of oxygen electrodes on coral reefs in 1961, my wife Barbara and I found that the low tide oxygen levels in water over the shallow reef-flat adjacent to Heron Island fell to about 40% of air-saturation on calm nights after midnight (Kinsey & Kinsey 1967). During my very extensive early studies at One Tree Island in 1967-8, I found that the shallow back-reef environment also exhibited levels of about 40% saturation under similar circumstances (Kinsey 1972). It seemed that 40% of saturation may have some limiting metabolic significance. However, in work done at Heron Island during 1970 for the *Royal Commission on Petroleum Drilling on the GBR* a lagoon back-reef environment similar to the one used at One Tree Island exhibited levels as low as 15% (Kinsey 1973).

In summarising these findings in my PhD thesis (Kinsey 1979) I indicated that, whereas Heron Island back-reef seemed to approach 15% saturation regularly on calm, spring-tide, late night lows, One Tree back-reef typically approached 40% on similar calm, late night lows. However, the lagoon level was so elevated at One Tree that there were several neap tides each year where the highs were actually so low that negligible rise occurred in the ponded lagoon. At such times, the low tide ponded water condition actually persisted for close to 18 hours. On these occasions, when the final stages of the low water occurred just before dawn, the oxygen level was measured at 14% -- essentially the same level as occurred on the Heron back-reef on a more regular basis. So it seemed that 15% saturation might be the value that really had some limiting metabolic significance.

There are two principal ways of interpreting these findings. My preferred option is that 15% saturation is the level below which a reef community cannot be supported. Thus, on a calm night in standing water, 15% is the metabolic draw-down level where metabolic consumption is balanced by atmospheric invasion. In such an area, no further increase in biomass could be supported. Thus oxygen availability is controlling biomass per unit area.

The second option is that the level 15% is not critically related to biomass but represents a point at which any reasonable reef community biomass will reduce its metabolic demand such that the oxygen saturation does not fall below 15%. I realise that there is plenty of evidence in the literature for reduced metabolic demand by many organisms at low levels of available oxygen. However, in dealing with complete communities, we must bear in mind that much of the active biomass is of unsophisticated prokaryotes that will exhibit no such metabolic limitation.

The final episode in this saga relates to a rather tragic experiment we conducted in 1969. During 1968-9, I

had been using enclosures of vertical plastic fences up to the water level during the low tide standing water periods on the back-reef at One Tree Island (Kinsey 1978). These enclosures were of 3 to 5 metres diameter and designed to maintain the normal water to biomass ratio of the general area. They allowed fairly normal wind action on the surface of the water. The water was, of course, fixed in the enclosure but, as the conditions at the times of use were of standing water anyway, the fence did little other than ensure that no water exchange occurred. Numerous uses of these enclosures had given data that were in very close agreement with data from the surrounding unenclosed environment. The later experiments in this work involved nutrient modification of the water in the fenced areas. Finally, I decided to limit water availability by bringing the fences closer to the enclosed communities thus increasing the biomass to water ratio. The first of these experiments involved reducing the water volume by 50%. Most unfortunately and without my knowledge at the time, the experiment coincided with one of the uncommon 18 hour low tide sequences. Our study of the first normal low tide early in the night led to interesting data and resulted in oxygen levels being reduced to 20% or so compared with surrounding area at the usual 40% or so. We then retired for the night leaving the fence in place. On returning to check the oxygen levels at dawn the next day, we discovered that there had been no intervening high tide. The oxygen level in the general area had fallen to 14%. The oxygen level in the enclosure was 0% and most of the visible biota in the enclosure was dead or in extreme distress. For rather obvious reasons, I did not attempt any more closely monitored experiments of this kind.

The finding that the community was perfectly capable of drawing-down the oxygen level to 0% would seem strongly to support my preferred option that 15% oxygen saturation really was indicative of a biomass limitation not simply of metabolic shut down.

Clearly the suggestion of oxygen as a factor controlling biomass will not be relevant to shallow reef systems with continuous water flow but there are many systems in areas of high tidal range and particularly in fringing reef situations where standing water is a factor in the diel cycle. Perhaps the most significant thing that can be said of these unexpected findings is that it emphasises the importance of never dismissing incidental or serendipitous discovery without determining whether one has stumbled on something of real significance.

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Spawning of stressed *Montastraea cavernosa*

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Montastraea cavernosa is a gonochoric, broadcast spawning coral, spawning of which occurs in summer (August-October) between six and eight days after the full moon (Bastidas et al. 2005; Vize 2006; Budd et al. 2012). Nine, 15 cm long colonies were collected at a depth of 4.5 m on August 26th 2013, five days after full moon, from the reef lagoon of Puerto Morelos, Mexico (20° 51′ 13″ N, 86° 52′ 31″ W). Once the samples were taken out of the water, they were left under the sun for 30 min, and during that time they expelled mucus and ejected mesenteries (Figure 1A). Afterwards they were placed in an experimental tank with continuous seawater flow at 28°C, and covered with mesh to

mimic the original collection depth. The purpose of the experiment was to test if the colonies would spawn in spite of such stressful conditions, and to help understand how sensitive coral spawning is to acute environmental stressors. The observations were that nine colonies (at 21:00 hours) had fully extended tentacles (Fig 1B); at the time of the spawning the polyps were bloated and contracted (Fig 1C) and then they released eggs (Fig 1D). Time of spawning and the sex of colonies are presented in Table 1. The average time of spawning in all colonies was between 14.28 ± 7.5 minutes, with the male colonies being the first and the last to release. *In vitro* fertilization was successful, but there are no photographic records and the larvae did not settle. We conclude that *Montastraea cavernosa* colonies can still spawn despite an acute stress event (aerial exposure).

Day	Time	Sex	Sample label
26/08/2013	22:00	Male	9
	22:15	Female	4
	22:33	Female	3
	22:39	Female	5
	23:05	Female	1
	23:13	Female	6
	23:20	Male	9
	23:40	Female	7
	23:55	Male	2
27/08/2013	22:05	Female	8

Table 1. Date, spawning time, sex and sample label of *Montastrea cavernosa*. Note that coral 9 spawned twice.

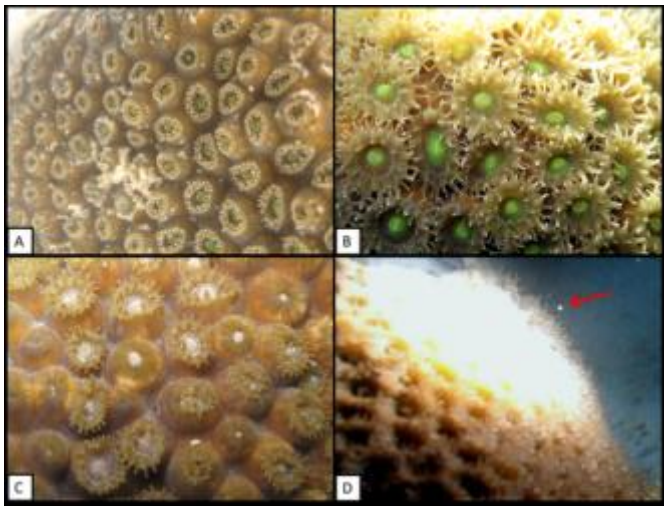

Figure 1. Polyps of *Montastraea. cavernosa* **A)** Stressed and ejecting mesenteries **B)** Same colony with extended tentacles at night. **C)** Bloated and contracted polyps just before spawning **D)** Releasing eggs.

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An overview of the coral bleaching event in the central and southern Mexican Caribbean in 2011

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Coral bleaching in combination with outbreaks of disease, a massive die-off of *Diadema antillarum* and major hurricanes during the last two decades has affected shallow reefs of the Mexican Caribbean, and contributed to the general decline of coral cover (McField et al. 2008). Coral bleaching events are now relatively frequent events, mainly affecting the southern Mexican Caribbean. We surveyed 100 km of coastline, in October 2011, in central (20° 24' 22" N, 87° 18' 11" W and 20° 7' 36" N, 87° 27' 40" W) and southern Quintana Roo (19° 05' 01" N, 87° 32' 55" W and 18° 30' 31" N, 87° 45' 25" W) using manta tows in reef lagoons and shallow reefs at depths of 2-8 m.

Extensive bleaching was mainly observed in the southern region, but a few pale colonies were seen in the central region. We recorded 15 species in states ranging from bleached to pale: *Orbicella annularis, O. faveolata, Agaricia tenuifolia, A. agaricites, Porites porites, P. furcata, P. astreoides, Acropora cervicornis, A. prolifera, Siderastrea siderea, Diploria strigosa*, *Millepora complanata*, *M. alcicornis*, *Erythropodium caribaeorum* and *Palythoa caribaeorum*. The most

a)

b)

c)

Figure 1: Examples of coral bleaching in reef lagoons and shallow forereefs in southern Quintana Roo (October 2011) ***a*** *Orbicella annularis,* ***b*** *Millepora complanata,* ***c*** *Agaricia tenuifolia.*

affected species, in terms of either number of cover or coral cover, were *M. complanata*, *A. tenuifolia, O.annularis, O. faveolata, Palythoa caribaeorum* and *M.alcicornis*. These species were extensively bleached or pale in the reef lagoon, back reef and shallow front reef, but no mortality was detected. Sea surface temperature anomalies during 2011 in the region were positive from March to November. Maximum positive weeks (DHW) in October. (http://coralreefwatch.noaa.gov/satellite/vs/caribbean.php). Our observant-ions indicate that bleaching was more severe in the southern region, similarly to the 1998 event where bleaching, disease and hurricane impacts had greater effects in the southern region of the Mexican Caribbean than in the central or northern regions (Kramer et al. 2000).

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Antipatharia in the Red Sea

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Information on the Antipatharia (black corals) of the Red Sea is extremely limited (Taviani et al. 2007; Fishelson 2009). Brook (1889) mentions that three species have been reported from the area: *Cirrhipathes anguina* Dana by Klunzinger (1877); *Antipathes corticata* (Lamarck) by Haeckel (1875); and *Antipathes isidis-plocamos* Ehrenberg by Ehrenberg (1834) and Klunzinger (1877). *C. anguina* has been described a number of times in the literature from various Indo-Pacific locations. The other two species are very poorly known.

Except for internet photographs, virtually no literature based on reliable taxonomic studies exists for the basin. This contribution provides a first preliminary assessment that can hopefully serve as a base for future biodiversity studies and monitoring efforts. To help identify nursery sites for the conservation of black corals in the Red Sea, a large-scale survey of forty-seven sites along the Gulf of Aqaba and South Sinai was conducted during April and October each year from 2006-2012, to a depth of 60m, using SCUBA.

Figure 1. *Antipathes spp* at 60 m depth growing horizontally off a vertical wall at Blue Hole, Gulf of Aqaba.

Of the forty-seven sites surveyed, only four sites contained black corals: Blue Hole (*Antipathes* spp); Ras Abu Gallum (*Antipathes* spp, *Cerrhipathes* spp); Ras Mamlah (*Antipathes* spp); and Shark Observatory (*Antipathes* spp). All Antipatharia (Figs. 1-4) were observed at 60 m depth and accounted for approximately 2-3% of the benthic cover at their locations. Antipatharian recruits were observed at all four sites.

Characteristics that distinguished these four sites from other survey locales were 1) biologically diverse reef walls supporting abundant coral and zooplankton (Figs. 1-4), 2) upwelling, 3) mild currents, 4) vertical secchi-disc measurements lower than at other sites, (12 vs 20-25m), 5) lower summer average surface temperature (25° vs 26.2°), and 6) lower average surface salinity (39 ppt in summer compared to 40.8 ppt at the other sites). The reef walls were also characterized by holes, crevices and overhangs that were covered with rich biodiversity (Fig. 4). The onshore topography at the four sites consisted of high mountains close to the sea and a narrow (10-50 m) intertidal zone that made the reefs susceptible to discharge that increased nutrient levels and lowered salinity. This could also have contributed to the higher turbidity.

Acknowledgements The authors thank the Nature Conservation Sector of South Sinai and the Egyptian National Institute of Oceanography and Fisheries (Gulf of Aqaba and Suez Section) for survey support, and Dennis M. Opresko and Marzia Bo for scientific advice.

Figure 2. *Cerrhipathes* spp. at 60 m depth off Ras Abu Gallum, Gulf of Aqaba.

Figure 3. *Antipathes* spp. at 60 m depth off Ras Mamlah, Gulf of Aqaba

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Figure 4. Close-up showing the rich infaunal biodiversity on an Antipatharian colony growing at 60 m depth off Ras Mamlah, Gulf of Aqaba. Foreground: amalgamation of coralline algae, ascidians, octocorals, Scleractinian corals, tubeworms, and Antipatharian recruits growing on the branches of an adult *Antipathes* spp.

REEFLECTIONS

(unusual locations or species)

Acropora **reef off Metundo Island, Quirimba Islands, northern Mozambique**.

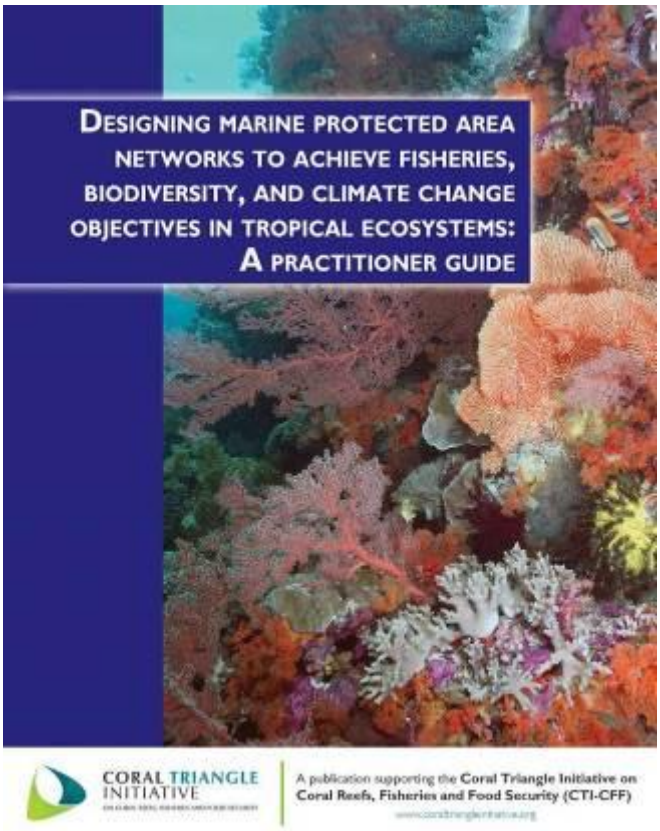
Most of the Quirimbas have low coral cover as a result of coral bleaching and high sediment loads, coming from local rivers. Metundo Is. however possesses some areas with very high coral cover, probably due to its location at the very edge of the continental shelf, exposing it to consequent upwelling of cooler waters. *Photo by Mauvis Gore*

BOOK & PRODUCT REVIEWS

Reviews of books, software, hardware and other products

Designing marine protected area networks to achieve fisheries, biodiversity, and climate change objectives in tropical ecosystems: A practitioner guide by Green, A., White, A., Kilarski, S. (Eds.) 2013. The Nature Conservancy, and the USAID Coral Triangle Support Partnership, Cebu City, Philippines. viii + 35 pp.

Reviewer: Sue Wells; email suewells1212@gmail .com



This cheerfully illustrated guide was developed through work described in an associated more detailed technical report (Fernandes et al., 2012) which brought together existing approaches to Marine Protected Area (MPA) network design and synthesised these into a set of 15 principles. This is a new addition to the growing literature on how to design MPA networks so that they achieve their objectives. Based on experiences with tropical ecosystems in the Coral Triangle, the guide is directly relevant to coral reefs and potentially useful for MPAs in the tropics worldwide.

The aim is ambitious: to provide guidelines for setting up MPA networks that will help simultaneously to achieve sustainable fisheries, biodiversity conservation and increased resilience to climate change. The guidance is based on the premise that existing design principles differ for these three objectives, and may even be contradictory. In particular, the authors note that:

- To contribute to sustainable fisheries: MPAs should be small enough and of an appropriate shape to maximise spill over; an MPA network should allow fishers access to unprotected areas but include MPAs that protect examples of all habitats from fishing; and an MPA network should be flexible to cater to fishers' needs.
- To provide biodiversity protection: MPAs need to be placed where relevant species and ecosystem functions are found, even when these locations are highly specific or even isolated;
- To provide biodiversity protection and increase resilience to climate change: no-take areas should be included within the network; and long-term protection should be assured to allow the restoration and maintenance of the full range of species and ecosystem functions;
- To improve resilience to climate change: sites that are "resistant" to climate change should be prioritized for inclusion in the network; emphasis should be placed on building connectivity among source *refugia* and susceptible sink reefs to enhance recovery; and at least three widely separated replicates of all major habitat types should be included in the network to spread risk.

I would question whether there really are such differences in design requirements to achieve the different objectives, but the concept provides food for thought and the principles identified must in any case be considered in the design of any MPA network.

The guide lists a set of prioritised principles that should be followed (see below). In it MPAs are defined as any clearly-delineated, managed marine area that contributes to protection of natural resources in some manner. Marine reserves (MRs) are defined as a type of MPA in which resource extraction is banned.

PRINCIPLES

1. Prohibit destructive activities throughout the management area.
2. Protect 20-40% of each habitat within marine reserves (depending on fishing pressure and whether there is additional effective protection in place outside the marine reserves, MR). Include habitats that are connected through movements of key species.
3. Ensure that there are habitat replicates protected within marine reserves.
4. Ensure that MR include critical habitats such as spawning, feeding and nursery areas.
5. Ensure that the MR have long-term (20-40 years), and preferably permanent, protection.
6. Include a multiple use MPA in the network that is as large as possible.
7. The MPAs within the network will vary in size, but the minimum size required for key species (which will partly depend on far they move) should be respected; MPA size will also depend on whether other effective marine resource management methods are in place within the network area.
8. Marine reserves should be separated by a distance of 1-20 km (with a mode of 1-10 km).
9. Include an additional 15% of key habitats in shorter-term marine reserves.
10. Locate MPA boundaries both within habitats and at habitat edges.
11. Create as many MPAs as possible in the network with square or circular boundaries.
12. Minimize and avoid local threats.
13. Include resilient sites (refugia) in marine reserves.
14. Include special or unique sites in MR (e.g. habitats that are isolated or important for rare and threatened species).
15. Locate more protection upstream

The rationale for the prioritisation is not entirely clear, since ideally all the principles should at least be considered. It would thus probably be advisable to use the guide in conjunction with the technical report where the principles and their rationale are explained in more detail. Only time, combined with monitoring the effectiveness of those MPA networks that are established using these principles, will tell whether using these principles really help us to address the three objectives simultaneously. This is nevertheless a useful contribution to the urgent need for more effective management of coral reefs.

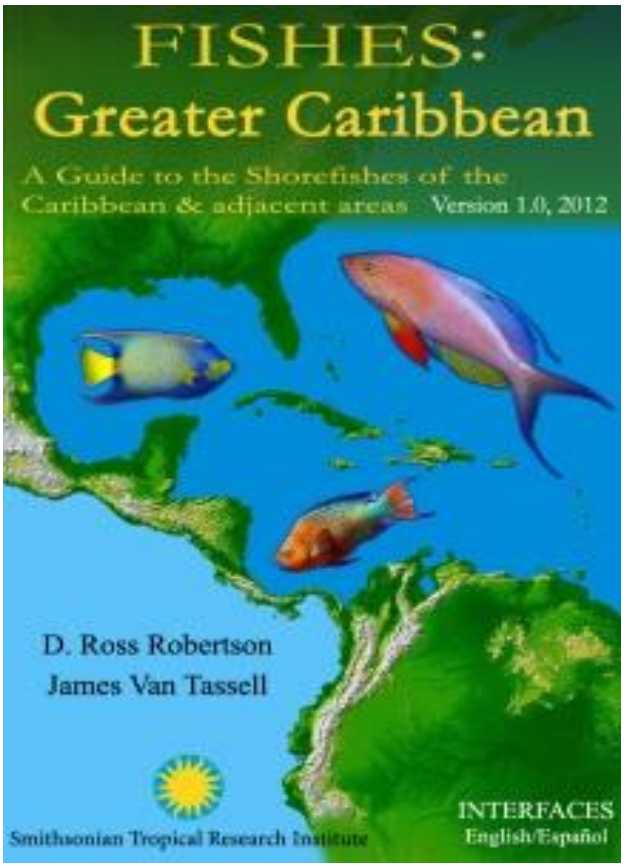
Reference

Fernandes L, Green A, Tanzer J, White A, Alinõ PM, Jompa J, Lokani P, Soemodinoto, Knight M, Pomeroy B, Possingham H, Pressey B (2012). Biophysical principles for designing resilient networks of marine protected areas to integrate fisheries, biodiversity and climate change objectives in the Coral Triangle. The Nature Conservancy for the Coral Triangle Support Partnership, 152 pp.

Electronic Guides to the Fishes of the East Pacific (by Ross Robertson & Gerald Allen) and of the Greater Caribbean (by Ross Robertson & James van Tassell), Smithsonian Tropical Institute.

Reviewer: William F. Smith-Vaniz, Florida Museum of Natural History, University of Florida; email smithvaniz@gmail.com

Image quality of reef fishes has benefited from several modern inventions. These include the general availability of SCUBA diving equipment and affordable, high-quality (images of 10 megapixels or greater) underwater digital cameras. These advances have resulted in excellent photographs of fishes including those whose identifications are challenging. In the past the only way one could attempt to identify such fishes was by trying to find its description or likenesses in a book or visiting a natural history museum collection. During the past decade a better alternative has been a downloadable CD-ROM or an identification application (app). Although several of these are available for the Caribbean and eastern Pacific, none are as comprehensive or useful as Fishes East Pacific (Ross and Allen) and Fishes Greater Caribbean (Ross and Van Tassell): both version 1 apps were released in iPhone format in 2012 and the East Pacific app is also available in iPad.



The general app features have been described in detail by Ross Robertson in his article in the Reef Currents section, so this critique will mostly discuss some minor suggestions for improvement.

I am most familiar with Caribbean fishes; the following comments will be primarily focused on that app. First, it is remarkable that the authors have been able to obtain over 5,500 images, the majority excellent colour photographs, of 1,600 species, including almost all representatives of 169 shallow-living families. Because the authors are ichthyologists, the text information is very thorough and accurate, and identifications are virtually error free. Inclusion of diagnoses, descriptions, size and habitat information for each species helps increase the user's identification accuracy, but more behavioural observations would have been welcomed, either in the general family or individual species accounts. In a few cases where multiple photographs of a single species are given, a few misidentifications were noted (i.e., primary photograph of "*Seriola rivoliana*" = *S. dumerili*) but these will be corrected in the next release. With only a few exceptions (e.g., broad Caribbean distribution shown for the pipefish *Syngnathus floridae* based on misidentified sight records of *S. caribbaeus*), the distribution maps also appear to be very accurate but may be slightly misleading. Verified sight or collection localities are sometimes separated by considerable distances and the depicted ranges usually assume that a species also occurs in the intervening area. Because of habitat restrictions and other environmental variables, such assumptions can be erroneous and spot distribution maps indicate known ranges only. I was disappointed that author/s and dates of the original description for species names were omitted. That information could easily be added to the text accounts. Why is such information important? It makes it easy for interested users to know when an unfamiliar species was first described and by whom or if the generic name has been changed. The general public may find this information unimportant, but researchers are always interested in it. Search options and other features of the app are all useful and easy to use, but may require a little practice to use them proficiently.

Experienced divers and ichthyologists in particular will probably already know to which family most species belong, but for others the fish shape search option can be extremely useful. The fish shapes have two levels. The first level is a general outline and on the right side of that drawing is an arrow that when tapped reveals secondary shapes including family representatives with similar shapes, e.g. the primary shark shape leads to 18 secondary shark shapes; tapping a check mark on the far right side of these images followed by tapping the number of matches listed in the upper margin reveals thumb-nail photographs and species names for all such matches. I found the primary shape options too limited and frequently had to guess (often incorrectly) which one would lead to the correct family. For example, the generalized goby image (which has two dorsal fins) leads to five secondary images, one of which (clingfish) has a single dorsal fin. Some secondary drawings with two dorsal fins (dragonet) also lead to images of species (puffers) with single dorsal fins. More drawings could have prevented such possible confusion.

Many small species, especially gobies and weed blennies, have restricted distributions and are often members of a species complex with non-overlapping distributions. As an ichthyologist, one of my pet peeves is that experienced divers who know their local fishes reasonably well often go to a different

Caribbean locality and report "positive" identifications that are actually based on misidentifications of look-alike species at the new locality. The combination of the location search feature of the Caribbean app and the accurate distribution maps should go a long way to alleviate this problem. It might also help to add a general section on fish identification with a strong recommendation to be very cautious about identification of species outside their known ranges and that documentation of such records with a digital photograph should be attempted if possible. It also might be useful in the same general section to remind users that some species cannot be reliably identified in the field, and that identification to genus only is preferable to a species misidentification. It may not be feasible in all cases, but giving the general locality where each photograph was taken would greatly increase their scientific value and probably be of interest to many users. Many models of digital cameras have built in GPS capability to help acquire location data.

The eastern Pacific app includes very clever pictorial identification keys for two species rich families, gobies (87 species) and croakers (76 species). While these keys appear to work well and will be very useful to ichthyologists, fishery biologists and others who have the opportunity to examine specimens, they will be of limited value to divers and photographers. No such keys are included in the Caribbean app but they would be another useful identification tool.

These apps are the only authoritative identification guides that cover so many species from such wide geographic areas, including photographs or drawings of each species. The few suggestions for improvement are not intended to distract from the high quality of these identification tools which will be very valuable to fishers, divers, photographers and scientists alike. They should also increase awareness of the great diversity and beauty of fishes and encourage their conservation. We all owe a great debt of gratitude to Ross Robertson for making these apps available. An added bonus is that they can be downloaded free from the App Store and that future plans are to make them equally available and capable of being used and downloaded from other major platforms or devices.

Cartoon by Terry Scoffin, who was an internationally known marine geologist and one of the earliest supporters of and contributors to Reef Encounter. He died over 10 years ago, but we still have some of his cartoons that are unpublished. Under the name of “Black Dog”, he drew a series of cartoons about Ross, a fictional biologist who had been shipwrecked for 17 years on a very small island”.

CONFERENCE REPORTS

Informative overviews of recent conferences and meetings

The Third International Marine Protected Areas Congress – IMPAC3 – October 2013

Report by: Sue Wells

IMPAC3 took place in the splendidly situated Pharo Palace conference centre overlooking the city and port of Marseille, France, and attracted some 1500 participants from 87 countries. The congress discussion focused around the so-called Aichi targets of the Conservation on Biological Diversity, notably target 11 which calls for the protection, through marine protected areas (MPAs), of at least 10 percent of the world's oceans by 2020. With current MPA coverage still less than 3 percent, there is a long way to go – one estimate at the congress was that, using the current median size of MPAs, a further 11.5 million MPAs would be needed to meet the target!

This meant that there was heated debate about the relative merits of small versus large MPAs, although the common sense view that both are essential, depending on the needs and characteristics of any particular area, must surely prevail. Much attention was given to the urgent need for, and complexities of, establishing MPAs on the high seas; but coral reefs were covered in many sessions, reflecting the fact that much of the science for MPA design and management has been developed in the context of these tropical ecosystems. Compared with many ecosystems, reefs are relatively well protected by MPAs, but as we know these have not turned the tide of decline. Climate change was of key concern, with the suggestion that this is not being considered sufficiently in the design of MPA networks, although the presumption is that MPAs can help to make reefs and other ecosystems more resilient.

Target 11 requires that MPAs should be established in the form of ecologically representative networks that are **well-managed**, and this latter qualifier is likely to be much more difficult to achieve. Effective management was discussed extensively, and IUCN introduced its plan for a "green" list of protected areas, through which sites will be categorised or certified, according to whether they meet approved standards and criteria.

Some felt that the science for MPA network design is now largely in hand and that the focus should turn to effective management which requires better integration of social science, as well as public understanding of the value of natural science. This will also require further demonstration of the benefits and role of MPAs. Several workshops addressed MPAs and ecosystem services, and how we can measure the value of these services in order to develop a new "green" economic approach[2]. Ecosystem services assessment (ESA) was thus well covered at IMPAC with discussion of regional and global initiatives such as The Economics of Ecosystems and Biodiversity (TEEB) Oceans and Coasts study (Beaudoin and Pendleton, 2012), a web-based platform to document the value of ocean and coastal ecosystem services around the world, and promote knowledge sharing.

One session reported on the study commissioned by the EU that had reviewed 145 papers assessing marine and coastal ecosystem services (Liquete et al., 2013). Not surprisingly, food provision, in particular fisheries, was the most extensively analysed ecosystem service, followed by water purification and coastal protection. Coral reefs were the third most studied habitat after coastal wetlands and mangroves. However, it was felt that MPAs are rarely designed to deliver ecosystem services, their main focus being biodiversity protection, and that there should be more attention on using MPAs to maximise services such as recreation, fisheries, and shore line protection. It was also noted that not every MPA will provide a high monetary value in ecosystem services, so we will need to find other ways of valuing MPAs.

[2] A green economy is defined by UNEP as one that "results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities".

The congress was followed by a 2-day ministerial meeting in Ajaccio, Corsica, at which six recommendations were presented in the form of the Ajaccio Declaration. In summary these were:

1. *Promote further effort to bring together local and national initiatives (of which there are now vast numbers as revealed by the congress) to establish MPA networks, to ensure that an appropriate global network is established.*
2. *Involve the private sector to improve management and help link MPAs with marine spatial planning to ensure that 100% of the oceans is sustainably managed, recognising that MPAs are one tool only.*
3. *Negotiate an Implementing Agreement through the UN Convention on the Law of the Sea to create high seas MPAs.*
4. *Promote the regional approach to the creation of MPA networks as this may be the most effective scale to work at – there are an impressive number of regional initiatives, from the well-established Coral Triangle programme to newer initiatives such as that for the Mozambique Channel in the Western Indian Ocean.*
5. *Develop innovative, sustainable financing mechanisms to support MPA establishment and management, and increase efforts to use MPAs to provide ecosystems services as well as protect biodiversity.*
6. *Engage society as a whole in all stages of MPA design, establishment and implementation. Numerous workshops testified to the critical importance of full stakeholder participation.*

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The Second Asia Pacific Coral Reef Symposium (APCRS 2)

Report by: Beatriz Estela Casareto, Graduate School of Science & Technology, Shizuoka University, Japan

The Second Asia Pacific Coral Reef Symposium (2nd APCRS), was held between the 20th and 24th June 2010 in Phuket, Thailand, and was attended by nearly 500 participants from 35 countries. The program had 463 oral and poster presentations and included 23 mini-symposia, 6 workshops and 12 distinguished keynote speakers. A student competition session, special meetings and 4 field trips were also conducted during the symposium. The Proceedings of this conference are now being published in Galaxea (the Journal of the Japanese Coral Reef Society) and contain 58 papers arising from the symposium, encompassing a variety of topics in coral reef science, including biology, earth science, social science, economics, conservation and management. The contributions clearly reflect collaboration by scientists to promote coral reef conservation in a changing climate.

Compared to previous events, the 2nd APCRS provided greater cooperation and more concrete programs for collaboration among all researchers and managers in the Asia Pacific region. The 1rst Asia Pacific Coral Reef Symposium, which was successfully organized by the Chinese University of Hong Kong, during 18th to 24th June 2006, served as a base for this 2nd APCRS and for the founding congress of the Asia Pacific Coral Reef Society. The Asia Pacific region is important both for its natural resources and its socio-economic contributions to the world. It is home to over half of the world's marine species. Coral reefs are one of the most valuable marine ecosystems in this region and support a human population of more than 500 million. Most people along the coastline depend on the coral reefs for their livelihood, mainly from fisheries and tourism. In many locations, rapid economic development and associated pollution problems also contributed to the destruction of coral reefs. These threats to coral reefs, together with those from global climate change, were addressed at the 2nd APCRS by coral reef scientists and managers from across the Asia Pacific region. It is hoped that the 2nd APCRS Proceedings will provide a valuable resource and stimulate further research on coral reefs, especially that directed at the conservation of coral reefs in the Asia Pacific region.

Reference

Yeemin T, Casareto BE, Yamano H, Sutthacheep M, Suebpala W (2013) Proceedings of the Second Asia Pacific Coral Reef Symposium, Galaxea, Vol. 15, Supplement (2013)[3]

[3] *These proceedings will be published on-line in Galaxea on the JCRS website (http://www.jcrs.jp/?page_id=1550) by the end of February 2014. It will be also available in CD upon request. CDs will be also available during the 3rd APCR to be held in Taiwan from June 23rd to 27th of 2014.*

16th Annual Meeting of the Japanese Coral Reef Society

Report by: Chuya Shinzato (Chair, JCRS16 Organizing Committee), Marine Genomics Unit, OIST, Japan. Communicated by Saki Harii, University of the Ryukyus, Japan

The 16th Annual Meeting of the Japanese Coral Reef Society (JCRS16) was held between December 12th and 15th, 2013 at the Okinawa Institute of Science and Technology Graduate University (OIST). There were 40 oral and 101 poster presentations, including 8 NPO posters. About 250 people attended the conference. During the conference a summary of coral bleaching observed in Okinawa Island during the summer 2013 was reported.

On the last day, two mini-symposia were held: the first on "Genomics and the Future of Coral Biology", and the second on "Issues and Approach on Biodiversity and Ecology in Tropical and Subtropical Coastal Area". The former aimed to explore the impact of 'next generation' sequencing technologies on coral research. The latter, which was co-organized by the JCRS, the Japanese Association of Benthology and the Japan Society of Tropical Ecology, aimed to understand the relationships among coral reef, mangrove and seagrass bed ecosystems, with a view to achieving the conservation of biodiversity and ecosystems.

Photo by Yu Nakatsuji

A number of prizes were awarded during the meeting. Prizes to students / young scientists for the best posters were given as follows: 1st, Fujise R., Hiroshima University; 2nd Shintaku K., Hiroshima University; 3rd, Honda H., University of the Ryukyus. The Kawaguchi prize for the best research by a young scientist was awarded to Chuki Hongo, PhD (University of the Ryukyus) for his study "Holocene reef formation history: problems and perspectives". The basis of his work was that coral reef ecosystems have suffered great losses worldwide, influenced by recent climate change and human impact. Therefore, a projection of reef ecosystem in to the near future is of significant concern. A knowledge of coral species encountered in Holocene drilled reef piles is important for understanding the formation and maintenance of coral reefs. The results will help forecast the future response of reefs to climate change and anthropogenic impacts.

Photos by Chuki Hongo

In addition the JCRS award for coral reef conservation activities was given to a group named "COLOR CODE", for their monitoring activity of the recovery process from severe typhoon damages of a huge coral community on Nanhanari Reef, Kume Island, Okinawa. The cover picture of this edition of Reef Encounter shows the community composed mainly of *Acropora horrida*, spread over an area several kilometers in length and 200 m in width, as it was before the typhoon. The community was severely damaged in 2011, but is now gradually recovering.

The next JCRS meeting will be held in Kochi, Japan, in autumn 2014. For more information please visit the website: http://www.jcrs.jp/?page_id=1598

9th World Sponge Conference and a Sponge Classification Workshop

Report by: Christine Schoenberg, Australian Institute of Marine Sciences, Western Australian Marine Science Institution, Perth, Australia

The 9th World Sponge Conference was held in Fremantle, Western Australia over 4th-8th November. The venue hosted almost 200 international scientists and stakeholders in the areas of research, policy making and administration. The sponge world comes together only every 3 or 4 years, which is why it is always an important and exciting event attracting key players and new recruits alike. A welcome reception at the Maritime Museum led into the meeting at the Esplanade Hotel in Fremantle, and each evening the guests could mingle during social events such as the Student Meet-and-Greet night at the Norfolk Hotel, the poster function at the Esplanade, a come-together at Kaili's Fishmarket to remember deceased sponge scientists and the infamous sponge conference dinner at the Fremantle Sailing Club.

Coffee break at the Esplanade Hotel, Fremantle

During the conference well over 100 talks and 17 speed talks were given and 108 posters displayed. Highlights included Manuel Maldonado's keynote talk that revealed that sponges can be far more important to marine silica cycling than diatoms, and standing ovations to the 'godfather of sponges' Rob van Soest, who substantially shaped our understanding of sponge taxonomy and systematics. Recent, significant developments in this area are principally based on molecular studies, including genomics. Presentations on the first day largely focussed on surveys and research conducted for industry partners and around Australia's coasts. The following days saw a variety of talks on population biology, ecology, taxonomy, phylogeny and evolution, biotechnology and many symbiosis-related contributions. Many students excelled with outstanding presentations, teaching the established spongers a thing or two. On Friday field trips took participants to Rottnest Island, with or without diving in perfect conditions, or on a cruise through wineries in the Swan Valley. The Saturday after the conference offered an intensive sponge classification workshop organised through the University of Western Australia; taught by 8 sponge experts, it attracted 22 enthusiastic participants. In addition, the Western Australian Museum opened its doors to allow delegates into the collections to peruse their special groups of sponges. With people arriving early and staying longer to happily explore Western Australia the conference was an overwhelming success. The next World Sponge Conference is planned to take place in Ireland.

REEF SIGHTS

"Reef science education must begin earlier" say experts!

ISRS MEMBERSHIP

ISRS membership is open to all persons interested in any aspect of the science of coral reefs. While the society's membership consists principally of researchers, managers and students with interests in coral reefs and associated ecosystems, other people with genuine interests in or concern for reefs, of any type, are welcome.

The benefits of membership include:
- Receipt of the Society's scientific journal *Coral Reefs* (either on-line or hard copy)
- Receipt of the Society's newsletter/magazine *Reef Encounter* (by email or on-line)
- Access to the Society's on-line membership services, including the on-line Membership Directory
- Reduced registration fees for the International Coral Reef Symposium and other meetings sponsored by the Society.

Full / Individual Member
Membership includes all the benefits listed above, but rates vary greatly depending on whether a hard-copy subscription or on-line access to the Society's journal Coral Reefs is preferred, and according to the mean income level of the member's country.

Student Membership
Student membership at a nominal rate is open to those registered at an institute of higher education for either a first or a higher degree. The benefits are the same as for a Full / Individual Member, and include hard copy or on-line access to Coral Reefs.

Family Membership
Family memberships are available for partners who live at the same address. Each receives the same benefits as Full Individual Members, but only one hard copy of any journal is supplied.

Sustaining Membership
Sustaining Membership is for those Members who would like to contribute extra to support the work of the Society. They receive additional minor benefits and their support is acknowledged in Society publications.

Honorary Membership
Honorary Membership has been conferred on a small number of members who have rendered special service to the society or otherwise distinguished themselves in the field of reef science.

Membership services are now operated by Schneider Group which provides such services to academic societies. They may be contacted at:

ISRS Member Services
5400 Bosque Blvd, Suite 680
Waco, Texas 76710-4446 USA
Phone: 254-399-9636
Fax: 254-776-3767
E-mail: isrs@sgmeet.com

The membership subscription varies considerably depending on the type of membership selected and the primary country of residence of the member. Very generous membership rates are available for students and residents of developing countries.

For details of current rates and to complete the on-line membership form or download a hard copy please go to the society's membership services page at:
https://www.sgmeet.com/isrs/membership/member login.asp

NOTES FOR CONTRIBUTORS

Reef Encounter welcomes the submission of Scientific Articles, News Items, Announcements, Conference Reports and Book and Product Reviews, relevant to the coral reef researchers and managers. We especially welcome contributions by young researchers with a fresh perspective and seasoned reef scientists able to integrate a lifetime of experience.

Colour pictures or other illustrations (normally 1 -3 according to article length) are welcome to accompany an item. Cartoons and stand alone pictures of special note may also be submitted.

Different types of item should be sent directly (preferably by email) to the relevant section editors (see inside front cover - page 2 – for details)

Types of Article

Reef Encounter accepts three distinct type of "Article". Note that it is a requirement that one or more authors of any of these types of article must be a member of ISRS.

The **REEF PERSPECTIVES** section takes 2-4 page articles which express a fact-based opinion about a scientific or

management issue. Our goal is to encourage thoughtful and stimulating discussion within and across disciplines and generations. Authors thinking of offering an opinion-type item are encouraged to consult the editor. Readers are encouraged to respond by writing letters to a GENERAL CORRESPONDENCE section (which we expect to include in future editions); however such responses should be well reasoned and respectful (in occasional contrast to the faster-paced open discussion characteristic of some email discussion-lists).

REEF CURRENTS takes 1-5 page articles which overview a topic or a programme with which the author is familiar or has become acquainted. Priority will be given to articles focusing on subjects which are relative new or poorly known or often misunderstood.

REEF EDGE takes short scientific notes or papers (scientific letters) of three-quarters of a page to two and a half pages in length. The intention is to provide a forum for recording observations of scientific or management value that may be too limited in scope to form the basis of a full scientific paper in a quality journal (such as Coral Reefs). It is especially intended that this section provide a useful vehicle for young scientists or those whose first language is not English. Nevertheless submissions must be based on adequate data and appropriate analysis.

For any of the above type of article no standardised division into sections is required; rather authors can propose section headings as best suited to their material. Similarly abstracts will not be used. However articles should be properly referenced, with typically 3 -12 publications cited in a reference section at the end. All types of article will be subject to refereeing by one or more suitably experienced referees.

Style and Format

Contributions should be clearly written in English and divided into paragraphs in a logical manner.

Pages are set with margins as follows: Top 1 cm; Bottom 1.5 cm; Sides 1.3 cm
Reef Currents articles are set as a single column across the page. Reef Perspectives and Reef Edge (and also Reef News) items are set as double columns with the gap between columns = 1 cm
The standard font is: Calibri size 11, with section headings in Calibri 11 Bold. Sub-headings are also in Calibri 11 bold, but set into the beginning of the paragraph.
References are in Calibri font size 10, and footnotes in Calibri font size 8.
Paragraph settings are: line spacing = single with a 10 pt line space after a return or at the end of a paragraph, but no additional line spacing before. There is no indentation on either side, except when lists or bullet points are inserted.

Figures & Pictures should have a resolution of at least 350 dpi and be of a size suitable to the format. Each should have an explanatory caption either below or alongside it. Captions should be reasonably full, but not too long. Leave a single line between a figure and a caption below it. Use "Fig." (i.e. abbreviated) in the text, but "Figure" (e.g. **Figure 1**) to start a caption

Tables are normally single column width, with large tables not normally being suitable for publication in Reef Encounter. Each should have an explanatory caption either below or alongside it. Leave a single line between a table and a caption below it.

References

For submissions to the REEF EDGE section (and also the NEWS, BOOK REVIEW and CONFERENCE REPORTS sections, the style of References should follow that used by Coral Reefs with no points or stops after initials or abbreviations, but with parentheses around dates, e.g. for journal papers and books:
Matsuura H, Sugimoto T, Nakai M, Tsuji S. (1997) Oceanographic conditions near the spawning ground of southern bluefin tuna; northeastern Indian Ocean. J Oceanogr 53: 421-433
Klimley AP, Anderson SD. (1996) Residency patterns of white sharks at the South Farallon Islands, California. pp. 365–374. In: A.P. Klimley & D.G. Ainley (ed.) Great White Sharks: Ecology and Behavior, Academic Press, San Diego.
A full list of abbreviations can be found and downloaded from the Springer website.

However for the longer articles submitted to the REEF PERSPECTIVES and REEF CURRENTS sections, to assist comprehension by non-specialists, the titles of journals and books should be spelt out in full.

A Note from the previous editor: I am delighted to see *Reef Encounter* being re-launched. It was a great shame that we could not maintain the newsletter as it was and that for so long we could not find anyone willing to tackle the problems involved. The last issue was number 38, January 2010. We made some progress collecting material for number 39 and I apologise to those authors who submitted articles that did not get published. If you think your material is still suitable for the new format newsletter, please do let us know. *Sue Wells*"