ENCOUNTER

Newsletter of the International Society for Reef Studies

REEF ENCOUNTER No. 30 September 2001

Newsletter of the International Society for Reef Studies

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CONTENTS

(Contents continued on back cover)

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The **International Society for Reef Studies** was founded at a meeting in Churchill College, Cambridge, UK in December 1980.

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."
In order to achieve its aim, the Society has the following powers:

i. To hold meetings, symposia, conferences and other gatherings to disseminate this scientific knowledge and understanding of coral reefs, both living and fossil.
ii. To print, publish and sell, lend and distribute any papers, treatise or communications relating to coral reefs, living and fossil, and any Reports of the Proceedings or the Accounts of the Society.
iii. To raise funds and invite and receive contributions from any persons whatsoever by way of subscription, donation or otherwise providing that the Society shall not undertake any permanent trading activities in raising funds for its primary objects.

The Society collaborates with Springer-Verlag in producing the quarterly journal *Coral Reefs*. This large-format journal is issued free of charge to all members of the Society, and concentrates on quantitative and theoretical reef studies, including experimental and laboratory work and modelling.

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EDITORIAL

As you can see we have made a few changes to **Reef Encounter**. These have been brewing from sometime now and we thought what better way to initiate the new look than with issue number 30.

This issue sees a shift in the editorial team with Maggie stepping down as the main Editor to become the Production Editor. She feels it's time for a smaller supporting role, but still wants to help develop how our magazine is presented and produced. Kristian is now Editor following in the footsteps of a distinguished group (Brian Rosen, Barbara Brown, Sue Wells, Callum Roberts, and of course Maggie Watson). They set high standards and provided the base from which the team hopes to continue to bring you an engaging and interesting magazine.

With the last issue we switched production schedule, to an issue earlier in the year. Unfortunately this meant the copy deadline (1st Jan) coincided (or collided?!) with **ISRS** subscription renewals, and the issue went to press without listing several of our sustaining members on the inside cover. The Society deeply appreciates the support of all our sustaining members and **Reef Encounter** would like to apologise for any embarrassment the omissions may have caused.

ISRS is a scientific society, and sometimes we wonder whether our magazine has enough 'hard science'. But we feel our niche is making research more accessible, and helping to relate science to management issues. In this issue we have introduced a new section entitled **Reef Briefs**. Here we give a snapshot of recent and pre-press articles in **Coral Reefs**. Maybe you'll be intrigued by an article outside your own specialty!

We also cover such topics as remote sensing surveys, the first marine park in the Comores and fishing of anemones in the Florida Keys, and our feature wonders if settling fish larvae could help sustain the aquarium industry. Earlier this year the International Coral Reef Initiative asked the society to prepare a briefing on sustainable reef fisheries, and the result is printed in full in the **Currents** section.

Please do let us know what you think of our new look. Your comments and thoughts will decide whether we will continue **Reef Encounter** in this format. Send us your articles, but have a close look at the **Notes for Contributors** on the back cover as we've also changed our referencing system to contribute to the more reader friendly format.

Kristian, Maggie, Maria João and Karenne
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ISRS COMMENT

From the President

A few events in the last couple of years encourage me to keep faith in the value of coral reef science to the broader community, and its capacity to make a difference for the better. The first was a telephone conservation I had with a public servant. This fellow – trained in science – was close to decision makers. He had the ear of an assistant to a politician in a western government whose opinion had some weight in coral reef policy. The chat was about global climate change, and the issue was the extent to which coral reefs could adapt. I off-handedly mentioned a related paper that had just come out in a peer reviewed scientific journal. I was delighted and surprised when he pressed me for details. 'Peer reviewed papers are worth their weight in gold' he said, or words to that effect. 'My advice carries a lot more weight if I can back it up with a reference to a peer reviewed paper in a good journal'. We were talking ecology, but we might equally have been talking about socio-economic aspects of coral reef conservation, use and management. The point being that a scientific paper with a clear take home message and a good pedigree can make a difference.

With their high public profile, global advocacy groups like World Wildlife Fund, Greenpeace, The Nature Conservancy and Conservation International

form a bridge between science, governments and the people. Too bad that the Hong-Kong 'International Express' (12 June 2001) translated WWF's report on the Great Barrier Reef into the headline "Reef 'has five years to live'". I guess we just have to accept such hyperbole from newspapers, and be thankful for the exposure. Pity about those tourists who will stay away because of it, though. But on the positive side, I believe the strength and effectiveness in the public arena of Ove Hoegh-Guldberg's Greenpeace report on global climate change and coral reefs has two foundations: the simplicity of the message (reefs are in trouble), and the presentation of scientific material provided in support of that message. There is plenty in the science that does compel us to press for curbs on greenhouse gas emissions, and nothing that convinces us that reefs will adapt quickly enough for our liking. None of the uncertainties in the science justify 'business as usual', but they do warrant further study and debate. Such as: which reefs are most at risk? What about adaptation, acclimatization and ecological resilience? The more we know, the better we will cope with whatever the future brings.

This June I was speaking on a live radio interview, when the interviewer hurriedly brought the interview to a close. 'This was supposed to be a good news story' she said, on air. 'Sorry – I'm not so sure it is a good news story'. I had come to a place in my rambling discourse where I was speaking of wholesale transformation of beautiful reefs into coral rubble, covered in seaweeds. The interview had been spawned by Andrew Baker's paper in Nature (June 2001) 'Coral reefs bleach to survive change'. It showed that corals can indeed take on better adapted zooxanthellae after bleaching. The response seems to be: 'So bleaching is good for corals, is that it? What about our reefs here in Western Australia?' Media are looking for good-news stories now. 'OK – you can stop just telling us reefs are in trouble. Now tell us which ones, and are there natural coping mechanisms, and what can we do to foster them?' I figure that to answer big questions like these, we need to do a great job in all the reef studies embraced by the members of this great Society. Go for it!

Terry Done
President

ISRS NEWS

2001 International Society for Reef Studies/ The Ocean Conservancy Fellowship Winner

The **International Society for Reef Studies** and The Ocean Conservancy awarded their 2001 Coral Reef Fellowship to Benjamin Ruttenberg, University of California, Santa Barbara. His project entitled "Larval retention and population connectivity in the Galapagos Marine Reserve" will investigate connections among regions of the park using the chemical "signatures" contained within the ear stones of larval fish. These signatures track the dispersal patterns of fish because they reflect the chemical composition of different bodies of water the fish travelled through. Mr. Ruttenberg will receive $14,500 for his research and will be supported for one year.

We received an unprecedented number of applicants for this year's award, with the panel of eight scientists reviewing 34 applications. Many thanks to all of the students who submitted proposals and thanks to the reviewers for giving their time to this important job. All of the applications were of the highest quality, and the selection process was very competitive. Although it was disappointing to have to decline so many worthy projects, Mr. Ruttenberg was the unanimous first choice of the judges. Congratulations to Mr. Ruttenberg and we wish him well with his research endeavors over the next year.

For information about the Fellowship contact: Peter Edmunds (Recording Secretary, ISRS), Department of Biology, California State University, 18111 Nordhoff Street, Northridge, CA 91330-8303, USA. Email: peter.edmunds@csun.edu
The Ocean Conservancy (formerly the Center for Marine Conservation) has its web site at www.oceanconservancy.org

Summary of Mr. Ruttenberg's winning proposal

Marine Reserves have become one of the most popular tools for managing and protecting marine resources. However, many marine animals, especially reef fishes, have long planktonic larval durations and are capable of dispersing out of even the largest of reserves. Population dynamics and recovery of exploited species will be strongly influenced by the connectivity of distinct populations, but actual levels of exchange have remained unknown for virtually all reef fishes. The Galápagos National Park Service has recently implemented a zonation plan for the newly created Galápagos Marine Reserve that includes a few large no-take zones. To evaluate the effectiveness of this plan, it is essential to have information on larval connectivity between different no-take zones and between no-take zones and zones open to exploitation. In order to measure rates of exchange between populations, I will use chemical variability present in the waters of the Galápagos as natural tags in the otoliths (earstones) of a reef fish. These natural chemical tags will allow me to explicitly identify larval sources and determine rates of exchange between populations. In addition to providing information directly to the managers of the Galápagos National Park, these techniques could create a method with which to generate this elusive but essential ecological information for marine systems worldwide.

Benjamin Ruttenberg
Email <ruttenbe@lifesci.ucsb.edu>

ISRS Publications Available

Replace copies of publications you have loaned and never gotten back, or extend your run! There are small numbers of some publications (2 or 3 in some cases), so order now to ensure you get what you want.

Back issues of **Coral Reefs** volumes 16, 17 and 18 are available at US$15 each issue (not volume).

Back issues of **Reef Encounter** numbers 1 (1983), 3 (1986), 4 (1988), 5(1989), 7 and 8 (1990), 9 and10 (1991), 13 and 14 (1993), 16 (1994), 21 and 22 (1997), 23 (1998), and 27 and 28 (2000), 29 (2001) are available and price varies depending on which issue you want.

Copies of the Proceedings of **8ICRS** (Panama) are available for US$200 (two volumes).

Copies of The Northern Great Barrier Reef (published in 1978 by the Royal Society) are available at US$25 each.

All prices include airmail postage. Payment must accompany an order (that is, no electronic sales, please) — payment is to be in US$ (if by check, it must be drawn on a US bank). Send orders to Daphne Fautin, **ISRS**, Kansas Geological Survey, 1930 Constant Avenue, Lawrence, KS 66047 USA. Inquiries to fautin@ku.edu.

A Note of Thanks from ISRS

At the **9ICRS** in Bali last October, Carden Wallace and Michael Aw donated to **ISRS** 40% of the income from the sales of their book "Acropora Staghorn Corals: a getting to know you and identification guide." The book sold well and the **ISRS** treasury grew as a result. Thank you Carden and Michael!!

ISRS Apology

The Society apologizes for the delay in arrivals of **Coral Reefs** during '00–'01. Paradoxically, the delay was largely caused by a practice that is intended to speed your access to published papers: electronic online publishing (see instructions inside the front cover of **Coral Reefs**). As soon as a manuscript is ready for printing, it is made available on line to individual, family, honorary, and sustaining members of **ISRS**. From that moment, there is a strictly followed practice that no changes will be made to the

paper, so authors and readers can be assured that the on-line and printed versions are identical. Electronic publication adds complexity to the already complex matter of publication.

We are learning. I apologize for the delay, and promise the editorial board is doing its best to get **Coral Reefs** back on schedule and to avoid such problems in future. In late May, incoming editor Dick Dodge, former Treasurer Daphne Fautin, and I met with a senior Springer official, Dr Wolfgang Engel, to develop a clear understanding of the circumstances associated with the past delay and how to prevent future ones. Policies were developed to ensure that on-line and printed versions of a publication bear the same year of publication.

As a member of **ISRS**, you can play your part in both keeping **Coral Reefs** on time, and helping us ever improve our reputation as the place of choice for publishing on reef studies. (Our standing among marine and freshwater journals has been consistently in the top 25% for the last decade, but we should strive to be right at the top, as we were briefly in 1992 according to citation and impact indicators). I would like the relationship between coral reef studies and **Coral Reefs** to reach the same level as that between medical research and the Lancet or the Journal of the American Medical Association. A paper in **Coral Reefs** should have standing equal to or better than one in Science, Nature, or any of our diverse disciplinary journals.

Please think of **Coral Reefs** as your journal of choice, and the Society will do what it can to justify that choice.

Terry Done, President ISRS

Coral Reefs - What's Going On?

Editor Dick Dodge says:

By now you will have read the letter to the membership from **ISRS** President Terry Done explaining some of the recent delays in **Coral Reefs** (see **ISRS Apology**) and outlining our plans to remedy the situation. Following the productive meeting with our publishers, Springer-Verlag, in May, we are all working hard to ensure you will receive three issues of Volume 20, and hopefully all four, this year.

There are some exciting things coming up in **Coral Reefs**. For example, some Reports and Notes will be highlighted in **Reef Encounter** (see **Reef Briefs**). This is a great development which we hope our readership will find helpful. Submissions to Coral Reefs remain strong and please continue to send manuscripts in to the Topic Editors (see details in **Coral Reefs Editors - Your Manuscript in Peer Review**). I particularly want to remind our readers about two Special Issues which are coming up soon. One is Guest Edited by Bob Buddemeier and Daphne Fautin, themed Large-Scale Processes, and the other is Guest Edited by Cliff Hearn and its theme is Hydrodynamics of Reefs. One will be published in this year's volume, and one in next year's.

Special issues are a traditional and valued feature of **Coral Reefs**, providing an opportunity to focus attention on an emerging aspect of the field. Folks with solid ideas for a Special Issue as guest editor should contact me by email at dodge@nova.edu.

Coral Reefs Editors - Your Manuscript In Peer Review

Quite a few of the Topic Editors for **Coral Reefs** have changed recently. So to give you an idea of who to send your papers to, here is a brief biosketch of each Editor. Choose the most suitable person for your paper – otherwise the team must redistribute the manuscript among themselves, slowing the review process. Once the appropriate Topic Editor receives your paper, he/she will then distribute it to a number of qualified reviewers who will consider it on its merits for publication. The Topic Editor evaluates and compiles the reviewers' comments to provide feedback to the authors. Our Topic Editors are among the most knowledgeable and best in our field!

You can find their respective addresses in a recent issue, or on the Springer-Verlag web site: link.springer-ny.com/link/service/journals/00338/edboard.htm.

Dr. Dave Barnes, one of three **Biological Editors** of **Coral Reefs**, is a Principal Research Scientist with the Australian Institute of Marine Science in Townsville, Queensland. He has worked on corals and coral reefs for more than 30 years, beginning his career with Tom Goreau in Discovery Bay. His current interests center around recovery of proxy environmental and climatic information from coral skeletons. His expertise in coral growth forms, skeletal structure, growth and calcification has helped improve our understanding of how environmental changes translate into changes in coral skeletal structure, and how information can be recovered from coral skeletons and interpreted. Work on proxy records brings Dave Barnes full circle; his earliest work recovered astronomical information about the history of the Earth-Moon system from coral skeletons. Between times, Dave Barnes has published on coral physiology, particularly physiological and biochemical mechanisms associated with coral calcification. He has also worked on reef community metabolism. He developed the pH-O_2 technique that improved by ten to a hundred times the resolution with which productivity and calcification can be estimated from changes in the chemistry of waters flowing over shallow reef communities.

Dr. Robert C. Carpenter, one of three **Biological Editors** of **Coral Reefs**, is a full-time university faculty member and researcher at California State University. His research interests center primarily on coral reef algal communities and the factors that affect their abundance, species composition, and rates of production. His particular interest is in how herbivores change the relative abundances of algae and other benthic reef components. This research demonstrates that herbivore effects are often the result of a modification of the physical environment experienced by the algae, especially the light and flow environments. His most recent research has focused on how light and flow drive algal metabolism across a range of spatial scales and how small-scale changes in the architecture of an alga or algal community influences the relationship between flow and algal production.

Dr. Howard R. Lasker, one of three **Biological Editors** of **Coral Reefs**, is an expert in evolutionary biology and ecology as well as in the population ecology of marine invertebrates. He is a professor at the University at Buffalo, State University of New York. He researches population ecology of *Pseudopterogorgia elisabethae*, a common gorgonian of coral reefs throughout the Caribbean. Colonies are harvested for pseudopterosin, a natural product that has antiinflammatory properties and which is used in cosmetics. Howard's studies include species recruitment, growth and survivorship, and population genetics, as well as developing methods for colony propagation that can be used in mariculture. A general goal is to identify the parameters that are crucial in analyses of coral populations and to determine whether there are "ecologic profiles" that can be used to differentiate species that should be highly protected from those for which managed harvesting is ecologically sound. Howard also studies how form develops and varies within individuals over their life spans, between individuals across habitats, and among species. This is important in understanding non-moving (sessile) taxa and their interactions with their environment and other plants/animals. Another interest is marine invertebrate life history strategies and how fertilization rates are a factor in life histories. Fertilization rates of eggs from Caribbean gorgonians vary from 0 to near 100% on different nights and at different spawning events. The fact that sperm limitation is found among these broadcast spawning species suggests a variety of reproductive strategies may be pursued by colonies and also suggests dichotomies between male and female colonies. Howard examines fertilization strategies among gorgonians using a combination of fertilization success models and other techniques.

Dr. Bruce G. Hatcher, Environmental Editor of **Coral Reefs**, has over 25 years experience working as a scientist, educator, and project manager in the fields of marine ecology, marine resource conservation, and integrated oceans management in 22 countries, three oceans, and four seas. Bruce works at Dalhousie University. He is a generalist with primary research expertise in coral reef ecosystems and benthic community dynamics. He has published more than 75 papers and reports on related topics and secured over $5M in grants and contracts. Significant contributions include the reconciliation of marine fishery development with marine biodiversity conservation in the Red Sea (UNDP); the implementation of integrated marine resource assessment and management projects in 12 countries of the Caribbean (Canadian International Development Agency); and the development of guidelines

for environmental monitoring of the Mesoamerican Barrier Reef (World Bank-Global Environment Facility). He has taught at all levels from high school field courses, to government employee training courses, to graduate student supervision. Bruce maintains effective collaborations with natural and social scientists, resource users and managers, and policy makers in both the private and public sectors. Currently he is interested in using numerical models to investigate ecological connectivity among coral reefs; new strategies for subregional cooperation in integrated marine resource management; remote sensing technologies for studying the ecology of shallow and deep water corals; and in linking marine ecosystem health to human health. Bruce is a capable fieldworker, being a certified coxswain and SCUBA dive master with over 1600 hours logged in underwater research and survey work, and having lived and worked in 16 of the Earth's less economically developed nations.

Dr. Peter F. Sale, Ecological Editor of **Coral Reefs**, an acknowledged authority on the ecology of coral reef fishes, has worked extensively on Australian and Caribbean reef systems for over 30 years. Peter is from the University of Windsor. *The Ecology of Fishes on Coral Reefs*, first published by Academic Press in 1991, and recognized as the authoritative work on the topic, was produced and edited by Peter. A second volume, *Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem*, will be published late in 2001. Peter has published over 100 scientific articles and numerous technical reports, and his lab has produced a further 50 journal articles. He played a major role in developing the science of reef ecology as a hypothesis-testing, experimental science, and has been instrumental in building understanding of the dynamics of reef fish assemblages. His work on community structure, organization, and dynamics is widely cited, and has had major impacts on ecology well beyond coral reef systems. He currently leads a major research project on fish recruitment dynamics and regional-scale ecological connectivity in the Meso-American coral reef system of Mexico, Belize, and Honduras.

Dr. Peter K. Swart, Geological Editor of **Coral Reefs**, has been working on coral reefs since 1977. He specializes in the study of trace elements and stable isotopes in the skeletons of corals in order to interpret climate records over periods of 100s to 1000s of years. In the past 20 years he has published over 90 papers on these and related geological, geochemical, and biological topics. Currently at the University of Miami, he is head of the Stable Isotope Laboratory. Peter is also heavily involved in the study of the South Florida Ecosystem and is head of the South Florida and Caribbean Cooperative Ecosystem Unit (SFC-CESU), a consortium of nine universities and organizations. The SFC-CESU is sponsored by the National Park Service, the United States Geological Survey, and the Bureau of Land Management to promote research in Federally owned lands in the region. Peter's ongoing research interests include studying the climate in the western and eastern Atlantic (with Dr. Richard Dodge), the flow of nitrogen through coral reefs, and the use of sclerosponges as proxy indicators of climate.

Dr. Richard E. Dodge, Editor of **Coral Reefs**, only accepts Reef Sites directly and has general charge of all successfully peer reviewed papers submitted by the Topic Editors. He is Dean of the Nova Southeastern University Oceanographic Center which conducts basic and applied research in biological and physical oceanography. Dick is also the Executive Director of the National Coral Reef Institute (NCRI) at Nova Southeastern University. This Institute is dedicated to performing applied and theoretical research on coral reef restoration, assessment, and monitoring. Dick's research has centered on the growth rates of reef-building corals, coral reef structure, fossil coral reefs, the ecology of recent corals reefs, and techniques of coral reef assessment, including mapping. He has specialized in research on pollution (e.g., oil, sewage, sediment) effects on corals and coral reefs as well as mechanical damage from ship groundings. Dick developed techniques for assessing pollution effects to reefs, including historical chronology building through coral growth ring analysis. His fieldwork has taken him to many places including, Bermuda, Haiti, Saudi Arabia, Puerto Rico, Cape Verde, Barbados, Jamaica, the Virgin Islands, the Bahamas, Panama, Cayman Islands, Costa Rica, Cuba, and Florida. Dick has held grants and contracts for reef related work from the National Science Foundation, the Department of Energy, the U.S. Geological Survey, the U.S. Navy, Florida SeaGrant, NOAA, the Environmental Protection Agency, South Florida Water Management District, Marine Spill Response Corporation, Office of Naval Research, State of Florida, Broward County Department of Natural Resources Protection, and the U.S. Department of Justice.

Remembering Don McAllister

Don Evan McAllister died peacefully but much too early on Father's Day, June 17, 2001. With his passing, coral reefs have lost one of their most committed and effective defenders. Born in Victoria BC, Don was educated at UBC (BA, MA) and Univ. Michigan (PhD). He had a long and distinguished career as an ichthyologist at the Canadian Museum of Nature, working as a research scientist and curator. He was well known and widely respected among ichthyologists worldwide. It is through his global environmental efforts that the people of the reefs will remember him. He never forgot that coral reefs are a Developing World ecosystem.

Don founded Ocean Voice International (OVI), and re-mortgaged his Ottawa house to support publication of its magazine, Sea Wind, a publication that tried to bridge the gap between academic research and life in a coastal village. Long before "alternative income" had made it onto the radar screens of the multilateral donors and funding agencies, Don was putting his own time and money into the Netsman Project in the Philippines, which weaned local divers off the use of cyanide for catching aquarium fish, in favor of selective hand-netting. He co-funded production of the film "Coral divers say "NO" to cyanide", which has had wide distribution. He and OVI produced elementary school curricula emphasizing the marine environment, and well-illustrated manuals on coral reefs that could be used at the village level. At last count, these manuals were available in Tagalog, Bahasa Indonesia, Spanish and English. More recently, he and OVI supported production of the program "People of the Reefs", which covered a coastal zone environment and health project in Indonesia. Sea Wind itself had a global distribution.

Early in our association, I made the mistake of misspelling his name: "MacAllister." He, a man who had put himself in personal debt to support the ecosystem he loved, replied "REAL Scots are well aware of the amount of ink saved, over a lifetime, by omitting the 'ac' ". I will never forget him, at the 2000 Deep-water Coral Symposium in Halifax, confronting some large, aggressive, well-funded representatives of trawling companies who were angry that Don had exposed the damage their activities were doing to the benthos in general and corals in particular. With his bristly white hair even more bristly, he said "I am truly sorry if my comments offend you gentlemen, but I have to point out that the data were taken from your company's website!"

Last month, Elizabeth May, head of the Sierra Club of Canada, was on a hunger strike on Parliament Hill in Ottawa, for the relocation of people in Cape Breton whose homes had been built on contaminated soil. It is a measure of the man that, as he lay dying in the hospital, he sent her flowers.

We will not soon see his equal.

Mike Risk
Email <riskmj@mcmail.cis.mcmaster.ca>

ISRS European Meeting, 4-7 September 2002

As you will be aware, the 2001 **ISRS** European Meeting, due to be held in Eilat, Israel this October has sadly been cancelled. However, we are delighted to announce that the next **ISRS** European Meeting will be held in the University town of Cambridge, England in September 2002. This represents a return to the city in which the Society was founded in October 1980.

Accommodation and the Meeting will all be at Robinson College, one of the newer Cambridge Colleges with purpose-built conference facilities, for the period 4 – 7 September 2002.

Proposed themes for the meeting are as follows:

- evolution of reef biota
- advances in molecular biology and their application to reef sciences
- dynamics of reef ecosystems in space and time
- disease in the reef ecosystem
- management of reefs and marine parks
- reef geometries and sea level fluctuations

- corals as recorders of ocean-atmospheric processes
- coral growth and reef growth
- geological record of reefs and their diagenesis

Further information and registration forms can be obtained from:
www.isrs2002.org or by writing to: *info@isrs2002.org*

Tom Spencer, Chair
Kristian Teleki, Vice-Chair
Cambridge Coastal Research Unit, Department of Geography, University of Cambridge, Cambridge CB2 3EN, United Kingdom, Tel +44 (0)1223 339 775, Fax +44 (0)1223 355 674

STAP Award for the ISRS European Meeting In Cambridge September 2002

The organizing committee for the Cambridge meeting and the **ISRS** are pleased to announce a Student Travel Award for the European meeting (4-7 September 2002). The award program is designed to help graduate students from developing countries attend scientific meetings that would enhance their education. Funds (up to US$1200) are available from **ISRS** for round trip travel, with the student's food, lodging, and fees covered by the meeting host.

Applications accompanied by letters from at least two major professors regarding the graduate students status and active involvement with coral reef research are required. Applicants must also submit an abstract of an oral paper or poster that they would present if selected. The meeting hosts will solicit and review all applications and select the award winner.

Interested students should contact:

Tom Spencer, Chair, Local Organizing Committee, Cambridge Coastal Research Unit, Department of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN United Kingdom Tel +44 1223 339775 Fax +44 1223 355674 Email <info@isrs2002.org>

NEWS

NOAA's Satellite Coral Reef Bleaching Early Warning Products Aimed at Local Reef Sites Around the Globe

Abnormally warm sea surface temperatures (SSTs) are one of the major causes of massive coral reef bleaching in recent years. NOAA's Coral Reef Watch initiative combines space-based SST observations with *in-situ* data to continually monitor for early indications of thermally induced coral reef bleaching worldwide and provide SST and HotSpot anomaly charts as well as Degree Heating Week (DHW) charts as indices of thermal stress[1,2].

To provide improved and more focused services to local reef communities and scientists

This 'HotSpot technique' is successfully providing early warnings of thermally induced coral reef bleaching to the coral reef community[3,4]. The warning products are updated twice a week providing near real-time information[5]. To provide improved and more focused services to local reef communities and scientists, the National Environmental Satellite, Data and Information Service (NESDIS) Coral Reef Monitoring Program have developed the Tropical Ocean Coral Bleaching Indices page[6] and SST time series plots. These new products deliver collective thermal stress information for selected reefs[6,7] and are also linked from our home page[5].

The Indices page[6] displays thermal stress parameters extracted from the near real-time satellite SST, the derived HotSpot anomaly and DHW datasets for the satellite observations nearest the selected reefs. These locations are assumed to be the best representation of the conditions at the selected reefs. Although the SST anomaly, HotSpots anomaly and DHW charts posted on our Web site provide the global and regional patterns of the thermal stress, they are only graphical displays of the data and do not provide actual values. It is difficult, and presently almost impossible, to extract accurate numerical values for a particular location from these 2-D charts. Additionally, local scale patchiness of thermal stress makes it even more difficult to visually extract accurate information for any particular reef site, even using enlarged images. But now, through the Indices Chart, NOAA/NESDIS provides for the first time actual SST, HotSpot anomaly, and DHW data on the Web.

24 selected reefs around the globe are available

Currently, Indices for 24 selected reefs around the globe are available (Table 1)[8]. On the Indices page[6], the collective information of each reef site is posted in an individual cell of a table. Each cell contains the following information: reef name, latitude and longitude, near real-time Degree Heating Weeks (DHW) value (i.e. 12 week

Table 1. The 24 reef sites selected for the Tropical Ocean Coral Bleaching Indices.

		Location	
	Selected Reef Sites	**Lat.**	**Long.**
Atlantic Ocean	Bermuda	32N	64W
	Grand Bahama Island, Bahamas	26N	77W
	Sombrero Reef, Florida	24.63N	81.11W
	Puerto Rico	18N	65W
	Virgin Islands	18N	64W
	Glovers Reef, Belize	16.5N	87.5W
Pacific Ocean	Midway Atoll, US	28.3N	177.4W
	Maui, Hawaii	21N	156W
	Palmyra, Christmas Island	6N	162W
	Galapagos	1.0S	90.5W
	Fagatele Bay, American Samoa	14.4S	170.77W
	Tahiti-Moorea	17S	149W
	Enewetok	11N	162E
	Palau	7.27N	134.16E
	Guam	13.4N	144.8E
	Raine Island GBR, Australia	12S	144E
	Heron Island GBR, Australia	23.5S	151E
	Fiji-Beqa	18.46S	178.10E
Indian Ocean	Oman-Muscat	23.7N	58.6E
	Maldives	4N	72E
	Seychelles	4S	55E
	Cobourg Park, Australia	11.26S	132.29E
	Scott Reef, Australia	14.02S	121.85E
	Ningaloo, Australia	21.88S	113.97E

accumulation of HotSpot Anomalies), the historical maximum DHW value for the same period in the past 10 years, near real-time SST value, and the Expected Maximum Temperature value (also called the Maximum Monthly Means SST (MMM-SST) value) (Figure 1). Also on the page, the underlined latitude-longitude pair and 12WK Accum Today linkages have been added so users can directly connect the latitude-longitude with a map of the reef (Figure 1). The navigation bar on the left portion of the map page lists the links to the corresponding global/regional SST anomaly, HotSpot anomaly, DHW, SST contour, wind field charts as well as other related information. The 12WK Accum Today link directs the user to the corresponding two-dimensional DHW chart showing the regional thermal stress pattern over the reef area.

The bleaching threshold used for the HotSpot technique is 1°C above MMM-SST. The HotSpot anomaly charts show the SST anomalies against the MMM-SST, while the DHW charts show the accumulation of the HotSpot anomaly over the most current 12 weeks. The DHW value at any particular location, at any particular time, is the summation of the product of the HotSpot anomalies, valued at least 1°C above the MMM-SST, and their durations in weeks (a minimum of 0.5 week for our biweekly HotSpot product) over the most recent 12-week period. One DHW is equivalent to 1 week of SST at 1°C above the MMM-SST or 0.5 week of SST at 2°C above the MMM-SST. When the current SST at a reef site

⚠ Fiji-Beqa

18.46S, 178.10E

12WK Accum Today	7.1
Max 12WK	2(91)
Current Temp (C)	28.9
Exp. Max Temp	28.3

Figure 1. A cell on the Tropical Ocean Coral Bleaching Indices Web page of April 23, 2001 for Fiji-Beqa. Underlined items are clickable links. The ⚠ sign (in red) indicates the current SST at the reef site exceeds MMM-SST (i.e. "Exp. Max Temp" in the cell) at this location. When the SST continues to rise and exceeds 1°C above the MMM-SST, the reef name turns red.

exceeds its MMM-SST, a red triangle warning sign is added to the left of the reef name. When the SST reaches or exceeds 1°C above its MMM-SST, in addition to the warning sign, the reef name turns red.

The Web-accessible SST time series plots[7] show the SST variation at the selected reef sites since August 2000 through near real-time (updated twice a week as all other HotSpot products). The SST time series are produced using the same near real-time SST used for the HotSpot anomalies. The SST time series plots display the current trends in SST variation at these reefs (Figure 2). The SST bleaching thresholds (1°C above MMM-SST) for the corresponding reef sites are plotted to facilitate identification of occurrence, duration, and magnitude of the thermal stress. The HotSpot anomalies and DHW values can thus be easily inferred from the SST time series plots. The plots of past SST time-series at these 24 sites from 1985 through 1999 are also provided over 2-year intervals[9]. These time series are derived from NOAA/NASA AVHRR Pathfinder nighttime-only SST data at 9km resolution (the Pathfinder SST global data set is the best available satellite SST data). For recent years (2000-2001), for which Pathfinder SSTs are not yet available, we are showing operationally derived nighttime-only SSTs. This time series represents information on the long-term evolution of SSTs and the occurrence and magnitude of thermal stress, essential for ongoing coral research and management efforts.

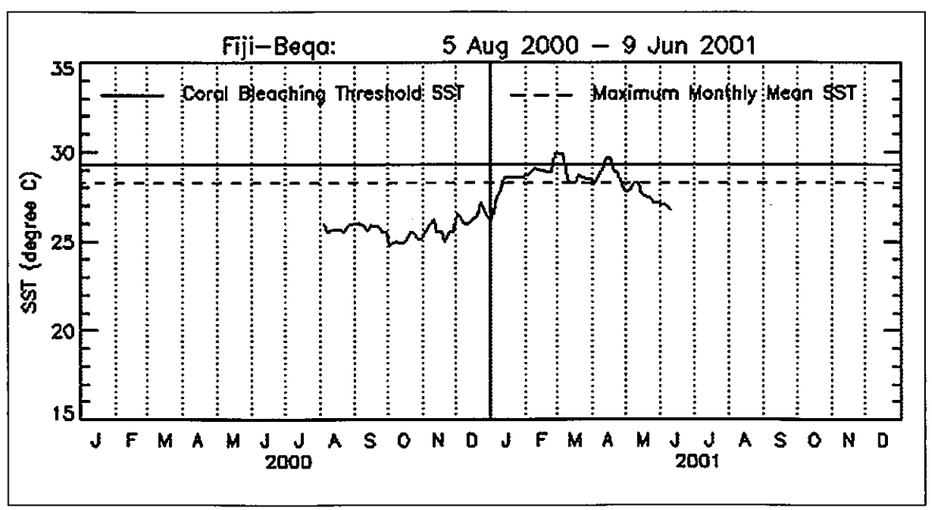

Figure 2. A sample plot showing the SST time series from 5 August 2000 through 9 June 2001 at the Fiji-Beqa reef site.

More reef sites will be added in response to requests from users. A user feedback form is available[10] to accommodate requests to list new sites on the Tropical Ocean Coral Bleaching Indices page and post the corresponding SST time series.

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9 http://orbit-net.nesdis.noaa.gov/orad/sub/sst_series_24reefs-path.html
10 http://www.osdpd.noaa.gov/PSB/EPS/indices_form.html

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Snorkeling Without Damage

I recently observed a clever system for allowing large numbers of snorkelers on a shallow reef with virtually no impact. At the Marine Park Headquarters on Pulau Redang island in Malaysia, up to 800 people snorkel on a small reef on the busiest day of the year. There are an average of 48,000 snorkelers per year at this site. The reef is quite small, maybe 10 meters wide and a few hundred meters long. The reef consists of a dense bed of fragile branching coral- staghorn and *Montipora*. Further, the reef is in shallow water, about 1-2 m deep at low tide, 2-3 m deep at high tide. And yet the coral is all unbroken except for two tiny spots I found the size of a foot. The coral appears totally healthy, with no dead areas. How do they do it? First, snorkeling is only allowed at high tide. Nearby resorts bring the snorkelers by boat, and a flag on the pier indicates when the snorkelers can be there. Second, all snorkelers are required to wear a life jacket when in the water. This keeps them on the surface, and they don't need to stand up. Third, they aren't allowed to wear fins. Compliance is very high, and easy to observe, since it's in front of the park headquarters and there is a high pier. The snorkelers are virtually all beginners, so they don't mind. There is a charge for using the snorkeling area of RM5 per adult, just over US$1. More advanced snorkelers can go to other spots where the water is deeper and snorkeling use much lighter. No fishing is allowed within two nautical miles of the entire coast of the islands that are marine parks. The user fee now supports nearly the entire marine park unit including fishing law enforcement. The system was devised by the head of the local Marine Parks unit, Rahim Gor Yaman, and implemented by the able staff. An innovative and shining example!

user fee now supports nearly the entire marine park

For more information, including educational materials, see the Marine Parks website: agrolink.moa.my/dof or e-mail Rahim at rahimgy@tm.net.my

Doug Fenner Email <d.fenner@aims.gov.au>

A New Web Site for Coral Reef Protection

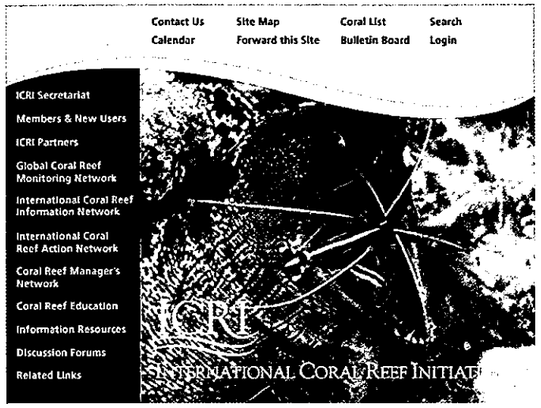
www.icriforum.org

You might view this electronic partnership forum as a house, a "mall" or even a meeting hall. The forum provides the space and some services in a centralized location, but there are specific rooms, shops, places or "desks", where various activities take place.

The left-hand menu shows the major themes by which ICRI-related information is organized (such as the ICRI and its secretariat, Members and New Users, ICRI Partners, the Global Coral Reef Monitoring Network, International Coral Reef Action Network, etc). Users can go into each of these areas to learn about ICRI (its history, secretariat, key documents...) and the main Networks that help form the ICRI partnership. Keep in mind, however, that many of these are under development, and more information will be added when each theme's stewards begin adding and updating sections with information.

By registering with the ICRIForum, you'll be able to:

- Create and submit a "Kiosk" that reflects your organization and its role in coral reef conservation and management. You can also list your organization's web site, post calendar events and news items for others to see. The Kiosks are easily searched and can help other members find information about you and your organization more readily.
- Members can post information to the Forum's bulletin board in almost any file format for others to review and download.
- Members can open either public or private discussions, and can even select which of the Forum's members can participate.
- Members can also have various types of information posted under the ICRIForum's "Information Resources" section. For example, this area holds



an on-line Library, a volunteer section, and job postings, among other items.

Like almost any other site, this one is under development and will be undergoing additions and changes. However, its evolution is predominately up to you, as a member. So please provide feedback to ensure that this Forum reflects the performance and features needed to make a difference in communications, and in helping to effect positive changes toward coral reef conservation and management.

> helping to effect positive changes toward coral reef conservation and management

The ICRIForum was designed, developed and continues to be support by the World Bank. Since the beginning of 2001, the ICRIForum has also received significant financial support from the French Ministry of Environment in posting content and website stewardship.

For more information contact: administrator@icriforum.org

Remote Sensing Survey - What is Required?

There is an increasing range of remote sensing data sets available for coral reefs, but we still can't consistently identify indicators of reef condition or produce reliable ways to detect change, and so monitoring coral reefs with remote images is still very much in the developmental stage. In the author's recent survey, potential users identified what they considered to be the major constraints. Most think expense is the biggest limitation, but many are unsure of the actual cost of their data, perhaps because governments subsidize images, or special research allowances are made, or simply because the data is bought infrequently. Certainly, the cost and time involved in applying remote sensing for coral reef monitoring activities is not well understood, and as a large portion of the world's coral reefs occur in the waters of developing countries, financial considerations are important. The need for highly trained interpreters to understand and extract the information was the other most common constraint.

> The survey identified a strong need for further research that addresses the needs of managers.

In the survey we targeted approximately 250 people from coral reef research, survey, monitoring and / or management organizations. Sixty-four responded, 62% of which were already using remote sensing. Respondents had differing information and reporting requirements; for example they were monitoring differing environments (coral reefs, seagrass beds, mangroves) and varying sizes of sites. At the moment, remote sensing is used mostly for benthic habitat mapping, coastal zone management and change detection. Rehabilitation monitoring and associated tasks are not common because they are so complex.

Remote sensing users are developing analytical techniques to go with newly discovered technologies, and although aerial photography is still commonly used for reef mapping, interpretation of satellite data is becoming more commonplace. The survey identified a strong need for further research that addresses the needs of managers. In particular, we recommend work which focuses on identifying and developing algorithms (and related spectral resolution) which relate a reef's bio-optical properties to relevant biophysical controls; work which develops better techniques to remove the effects of the overlying water; and which improves the way biogeochemical information (eg. climatic and oceanographic data) is incorporated into remote sensing interpretation. Finally, we need to use a greater range of image data sources (eg. MODIS, IKONOS, SeaWiFS) and fine tune their interpretation for coral reef systems.

K. Joyce, M. Stanford and S. Phinn are at the Biophysical Remote Sensing Group, Department of Geographical Sciences and Planning, University of Queensland. Email <k.joyce@uq.edu.au>
You can contact them for a full review complete with graphs. They thank the many people who responded to the survey and provided other contacts and additional literature

Balinese Biodiversity

Bali is distinctly part of the centre of maximum marine diversity! A team of 12 marine scientists (three from Indonesia and nine from the Netherlands) recently investigated how much the underwater fauna of the Lombok Strait resembles that of neighbouring seas. Bali's coral reef fauna is richer than that of Java and Sumatra, as rich as that of Ambon and North Sulawesi, and although poorer than South Sulawesi, the coral reef fauna of Bali ranks among the richest in the world.

Despite the importance of diving tourism to Bali, the Balinese underwater life has not received much attention from the scientific community. The team focussed on three coastal areas: 1) Sanur and Nusa Dua, south-east of Bali, 2) Tulamben, at the north-east coast, and 3) the islands Nusa Lembongan and Nusa Penida in the Lombok Strait. Together, these areas showed a great variety of reef habitats.

The coast of Sanur and Nusa Dua consist of slowly declining reef slopes with extensive reef flats and

beaches above and sandy reef bottoms underneath. The coastline is exposed to the Indian Ocean swell, which has its impact on the reef profile and the reef fauna. The beaches consist almost entirely of dead, hard, calcareous skeletons of Foraminifera, and living populations of these were surveyed on the reef. Here, species were discovered that were previously only known from the Pacific Ocean. A soft coral species discovered earlier at North Sulawesi appeared to use a sponge as obligatory substratum, which is a unique kind of symbiosis. We found a mushroom coral species that was only known from Taiwan and Ambon. In addition, a great variety of sea slugs, shrimps, sponges and other marine animals were encountered.

coral reef fauna of Bali ranks among the richest in the world

Tulamben is famous among divers because of a WW-II shipwreck at snorkelling distance from the beach. The base of the reef slope is volcanic sand with low coral cover. Since fishing is not allowed, fish are not shy. Here, the diversity of marine life appeared higher than at any other place around Bali.

The islands Nusa Lembongan and Nusa Penida consist of high limestone rocks. The large water masses transported from the Pacific to the Indian Ocean, together with the oceanic swell, create special conditions here such as strong currents and cold upwelling. We discovered a new species of coral with a coloured skeleton reminiscent of candy - and therefore called candy coral. Parasitic snails, probably new to science, were also found on this coral.

Bert W. Hoeksema, National Museum of Natural History, Leiden, The Netherlands. Email <Hoeksema@naturalis.nnm.nl>, Ir. M.I. Yosephine Tuti H., Research and Development Centre for Oceanology, Indonesian Institute of Sciences, Email <Shar@indo.net.id>, Ketut Sarjana Putra, WWF Indonesia-Wallacea Bioregion, Email <kputra@wwfnet.org>.

Coelacanth Inspires Community Conservation

Seventeen young people from villages on the Bunaken and Manado Tua islands within the Bunaken National Park in North Sulawesi have formed a conservation group – Team Raja Laut, or TRL. The idea came from the villagers themselves, who developed a keen interest in the Sulawesi Coelacanth (Raja Laut, King of the Sea in Indonesian) and a pride in protecting them. The TRL has conducted daily fisheries surveys to monitor for catches of Coelacanths, as well as sharks, turtles, dugongs and other protected species. Since its start in early 2000, the data collection quickly expanded to cover catches of commercially important fish and monitoring of illegal activities such as cyanide fishing, turtle egg poaching, bomb fishing.

The villagers get a say in how the money from the new entrance fee system is spent

Although TRL haven't yet recorded any Coelacanth catches, their activities build awareness of both the Coelacanth and overall reef conservation issues within the Bunaken National Park. They've found two previously unknown turtle nesting beaches and helped in the arrest of seven cyanide fishers. And unlike most local NGO's, TRL members live and work independently in their own villages, meeting every month to collate fisheries data and share experiences and information. So they are in an excellent position to bridge the gap between the Bunaken National Park Management Advisory Board and their own communities. As the islands become zoned into conservation, community and tourism use areas the TRL have a key role in channeling information about the Park Management Plan to their own communities, and also provide a voice for their village. The villagers get a say in how they would like to see money from the new Bunaken National Park entrance fee system spent, 80% of which is for used for conservation activities. Suggestions include a mangrove re-planting scheme on Mantehage Island and a jetty for Bunaken village to guard against reef damage at low tide. TRL have also conducted socio-economic fisheries surveys in the remote islands of Sanghir Talaud, north of Bunaken National Park as part of the WWF Wallacea Bioregion Reef Fisheries Programme, and acted as translators and field assistants for research into the role of women fishers and also bycatch in pelagic and coastal fisheries.

If they can secure continuing funding, TRL hope to expand to cover the entire National Park. They plan to set up a Bunaken Concerned Citizens Forum to formalize discussion between the Park Management, the villagers and other stakeholders. They may try to get official NGO status and a charter, although that might mean TRL members and resources become centralized on the mainland, rather than remaining a more effective island-wide community network.

The recent decentralization in Indonesia could empower coastal communities with a greater sense of stewardship over their natural resources. Team Raja Laut is already making steps to conserve the ecosystems that provide livelihoods for more than 20,000 people.

Kate Gallop, is a M.Sc. student at the Centre for Tropical Coastal Management Studies, University of Newcastle, UK and has been working with the WWF Wallacea Bioregion Programme, Indonesia. Email <kategallop@hotmail.com> Website: www.wallacea.org

UPWELLINGS

Comment on the Article 'Distinguishing Predation Injuries Inflicted by *Drupella* And *Acanthaster*'

The crown of thorn starfish *Acanthaster planci* (COTS) and the gastropods *Drupella* spp. are common and voracious predators of coral tissue throughout the Indo-Pacific Ocean[1]. They typically feed at night and hide during the day, and so all we usually see is the coral skeleton exposed by their feeding. COTS and *Drupella* often share habitat and because the feeding scars are similar, it's difficult to determine which caused a particular coral injury[2]. In **Reef Encounter 27** (p12-13) Robyn Cumming suggested ways to distinguish the scars inflicted by COTS from those made by *Drupella*[3]. But there are exceptions to these features and I suggest that the only way to unequivocally attribute injury to either of these predators is to observe the perpetrator directly. The three features Robyn suggested are:

1. *Drupella* scars are "always at the edge [of the colony] and never in the middle of live coral tissue".
2. *Drupella* scars often have "a banded pattern of algal covering, graded from white recently killed areas to dark old scars with heavy algal covering". In contrast, COTS scars " were inflicted at one point in time and developed a uniform algal covering..."
3. *Drupella* grazes "the branch bases first. Conversely, COTS scars were often on the tips of branches with the basal parts left alive."

Drupella do not always begin feeding at the edge of the colony. The snails can begin eating from the base of branches in the center of the colony leaving branches denuded of tissue surrounded by healthy branches. Indeed, a similar feeding pattern is shown in Robyn's Fig. 2 from her related article on Drupella aggregations[4]. A patch of exposed skeleton is seen in the center of an otherwise healthy *Acropora* colony.

A banded pattern is not restricted to scars inflicted by *Drupella* and not all *Drupella* scars are banded. The accompanying photo shows an *Acropora hyacinthus* colony partially eaten by a COTS, which was hiding beneath the colony. The exposed skeleton is banded demonstrating that COTS scars are not always inflicted "at one point in time". COTS may take a number of days to consume a colony particularly when the colony is large and the starfish

small. The tissue at the base of branches can be clean and white and could easily be mistaken for bleached tissue without closer inspection.

Certainly, *Drupella* typically begin feeding at the base of the branches of colonies and COTS typically feed when sitting on top of colonies. However, one exception is large open branching staghorn colonies where COTS begin feeding at the base of branches that are the most accessible part of the colony.

In summary, there is no simple way to identify the perpetrator of a particular feeding scar. The only way to unequivocally attribute injury to a particular predator is to observe it directly. Consequently, attributing coral damage to one or other of these predators will be difficult, particularly when both are locally abundant.

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Robyn Replies.....

Andrew has some useful points to make that could add to the story, but a couple of his quotes are out of context. My article said Drupella scars were always at the edge of live tissue, not always at the edge of the colony as Andrew has interpreted it. So in fact there is little disagreement here. Also, in his comment on banding patterns Andrew has missed the point I was discussing 'corymbose species (with small closely packed vertical branches)'. His quote doesn't include this bit of the original article. The distinction is important because the length of vertical branches in plate corals is minimal and probably doesn't prevent a cot stomach from reaching the bases - the result is the entire top of the coral is devoured rather than just tips of branches. Further, in Andrew's image of a plate coral it would be interesting to know the colony size, and also the size of the COTS.

A natural progression from this discussion would be collaboration in further research. I look forward to hearing more on the topic!

Robyn Cumming
Email <cumming_r@usp.ac.fj>

An Acropora hyacinthus *colony eaten by COTS. The exposed skeleton is banded as a result of the skeleton being exposed to algal colonization for different periods of time. The perpetrator was hiding beneath the colony.*

Whole Reef Health?

Coral reef health is poorly defined by reef researchers, probably because it is difficult to characterize. In the past few decades scientists have described the state of the reef, the susceptibility of reefs to degradation, or the conservation value of reefs. Many papers have been written on disturbances, diseases, whether or not reefs are geologically robust or biologically fragile and vice versa. Scientists have described reefs as more or less disturbed based upon percent live coral coverage, a mortality index, coral growth rates, or the presence or absence of certain bio-indicators, for example corals and fish. Such factors are essentially based upon changes in ecological conditions in the past forty to fifty years and ignore geological conditions. Researchers judge 'health' based upon these proxies, but little has been written on what coral reef 'health' actually is.

an almost hypothetical baseline

To help with a definition, lets assume that researchers discussing the reef and using the words status, state, risk, and disturbance are discussing reef health. A measure of health should describe the present state of a system compared to optimal functioning, reproduction, stability, disease, and minimal abnormality. But like many organisms and natural systems, a coral reef has a natural equilibrium position that will fluctuate above and below the most healthy state. So when defining coral reef health we must try to measure it against an almost hypothetical baseline. When and where would such an optimal reef have existed? Did this "healthy" system exist before the 1960s when the scientific literature began to document degradation of the reef and outbreaks of Crown of Thorn Starfish? Or was it before industrialization in the 1800s, or did it exist before changes in sea level 15,000 years ago? Spatial scales are also problematic. When discussing coral reef health are we talking about the organism level, or the entire reef, or does the reef also include the other ecosystems surrounding it such as seagrass beds? Then again, each region and each reef is a unique habitat that does not have a set standard for what is healthy and what is not. Low live coral coverage in the Pacific is not a sign of bad health, but it may be for Southeast Asian reefs. Few reefs in the South Pacific have more than 50% coral coverage due to high wave energy, tropical storms, and dominance of coralline algae[1]. In addition, leeward sides of islands generally have 15-20% higher species diversity than windward sides because of wave energy, reef formations and structure[2].

So how can we assess and quantify coral reef health? I suggest we should take a whole reef perspective. For example, changes in coral health and symptoms of degradation affect fisheries production and also the maintenance of reef structure. A healthy reef provides the production of fisheries that it did in the past (especially fish and mollusks), and sustains healthy coral populations that have long-term species diversity. Coral producing zones will be neither bare nor invaded by excess populations of non-reef-building organisms such as fleshy algae, soft corals or zoanthids.

A coral reef is an organic structure made from living corals and other reef-building organisms, and their calcareous remains. A whole coral reef perspective encompasses all of the species populations living together and interacting in this habitat. Only taking percent live coral coverage as an indicator for reef health would ignore how measures of species diversity and species evenness can highlight disturbance and stress in coral ecosystems[3]. For example, coral species diversity may vary over time because of natural perturbations such as hurricanes. After a major disturbance a few opportunistic species may dominate for various periods before diversity again increases[4]. Coral growth rates can also be misleading even if the reef is in decline[3] as growth rates can decrease where corals suffer sedimentation[5] but conversely can increase in waters with low nutrient inputs from sewage[6]. By examining several factors, such as bio indicator species, coral cover, growth, disease[7], and clonal health[8] we might understand how to manage reefs better and gain an insight into causes and consequences of different types of disturbances.

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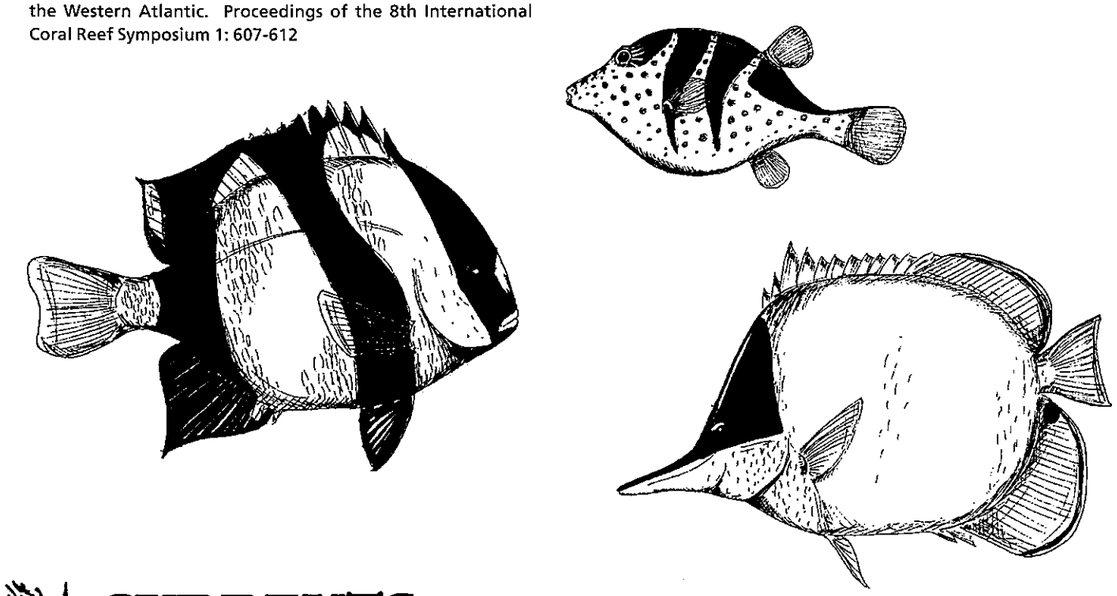


CURRENTS

Protecting Critical Coral Reef Habitat in the Tortugas Ecological Reserve

The Florida Keys National Marine Sanctuary (FKNMS) recently gained the final approval needed to implementat a fully protected marine reserve in the remote Tortugas region of the Florida Keys, USA. The Sanctuary's Tortugas Ecological Reserve is a 517 km^2 (151 square nautical miles) no-take marine reserve that consists of two sections, Tortugas North (312 km^2 or 91 snm) and Tortugas South (205 km^2 or 60 snm) (Figure 1). Tortugas North includes Sherwood Forest, an area of lush coral growth, and the northern half of Tortugas Bank, an extremely productive area of the Sanctuary. Tortugas South will protect Riley's Hump, an important spawning site for snapper and grouper and adjacent deepwater habitats for golden crab, tilefish and snowy grouper.

The Tortugas Ecological Reserve will preserve biodiversity, maintain ecosystem integrity, and act as a reference site to help scientists discriminate between natural and human-induced changes to the Keys' ecosystem. Oceanographic patterns have suggested that a marine reserve in the Tortugas has a high potential for exporting planktonic larvae downstream to the Keys and the east coast of Florida (Figure 2). Restrictions on vessel discharge and anchoring in the reserve will also protect water quality and habitat complexity.

A Draft Supplemental Environmental Impact Statement / Supplemental Management Plan for the proposed reserve was published in May 2000. This document detailed several boundary and regulatory alternatives considered by the Sanctuary, including the preferred alternative unanimously approved by the diverse Tortugas 2000 Working Group and Sanctuary Advisory Council in June 1999.

Input from the public on the Draft Supplemental Environmental Impact Statement included over 4000 comments from throughout the United States and abroad. The majority of these comments were strongly in favor of an ecological reserve in the Tortugas area. In the final step of the process, the Sanctuary reviewed and responded to these comments in a Final Supplemental Environmental Impact Statement (FSEIS)/Final Supplemental Management Plan, which was released in November 2000.

> The no-take zone network in the Florida Keys National Marine Sanctuary is the first of its kind in the United States

Several other agencies are also working to safeguard the unique marine resources of the Tortugas region. The Governor and Cabinet of Florida, Florida Fish and Wildlife Conservation Commission, Gulf of Mexico Fishery Management Council, and National Marine Fisheries Service have all instituted various complementary regulations to preserve the unique Tortugas region. The National Park Service is in the process of creating an adjacent protected area in the shallow waters of the Dry Tortugas National Park.

The 9,950 km^2 (2900 snm) FKNMS is managed by the Department of Commerce's National Oceanic and Atmospheric Administration and the State of Florida. It is one of thirteen National Marine Sanc-

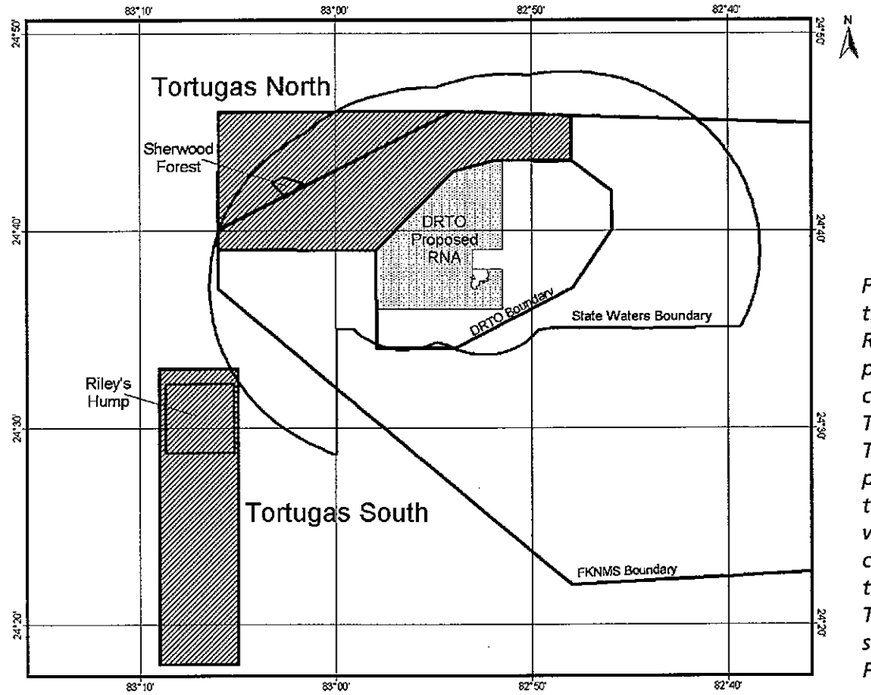
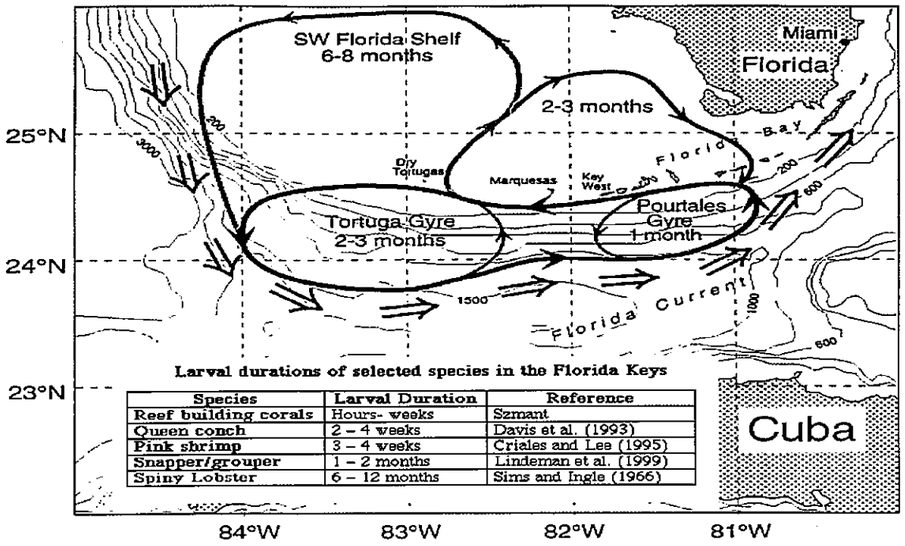


Figure 1. Boundary for the Tortugas Ecological Reserve, which is comprised of two sections called Tortugas North and Tortugas South. The Dry Tortugas National Park plans to implement a no-take zone within park water that will protect critical shallow reef habitats and complement the Tortugas Ecological Reserve (labeled as "DRTO Proposed RNA").



Larval durations of selected species in the Florida Keys

Species	Larval Duration	Reference
Reef building corals	Hours- weeks	Szmant
Queen conch	2 – 4 weeks	Davis et al. (1993)
Pink shrimp	3 – 4 weeks	Criales and Lee (1995)
Snapper/grouper	1 – 2 months	Lindeman et al. (1999)
Spiny Lobster	6 – 12 months	Sims and Ingle (1966)

Figure 2. Potential larval recruitment pathways in the Florida Keys (current data courtesy of Dr. T. Lee, University of Miami).

tuaries in the United States designated to protect significant natural and cultural resources such as the productive deep reef environment of the Tortugas. The no-take zone network in the FKNMS is the first of its kind in the country, and the Tortugas Ecological Reserve is the largest permanent no-take reserve in the United States.

For more information on the Florida Keys National Marine Sanctuary, visit *www.fknms.nos.noaa.gov*.

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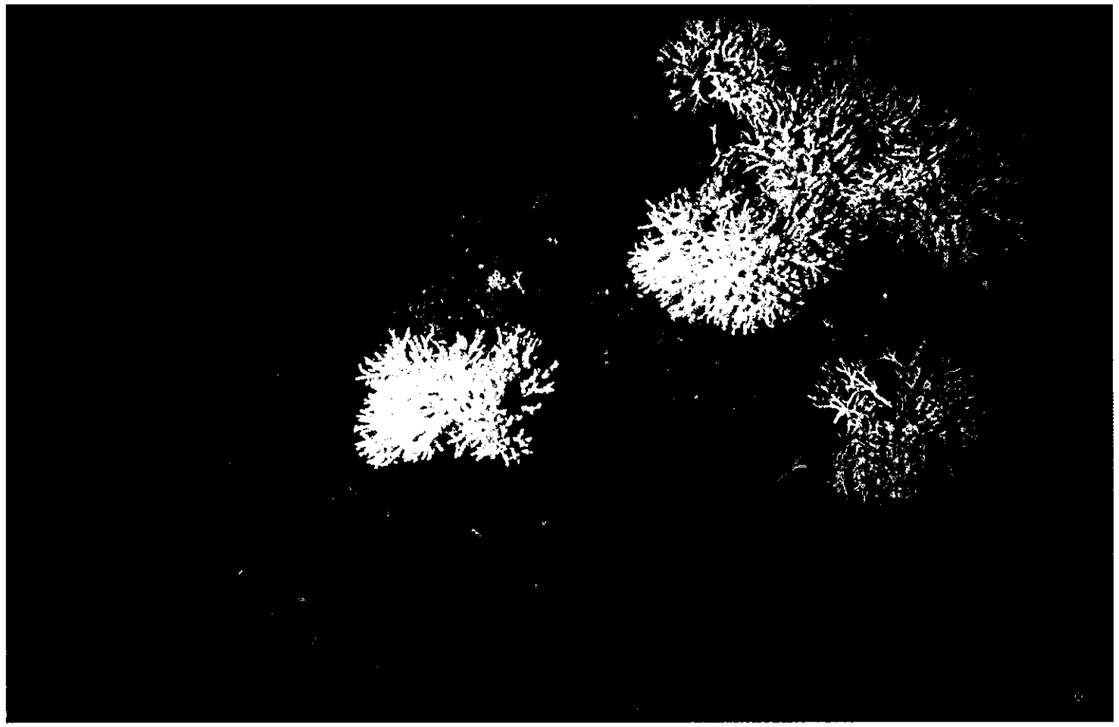
Deep-water Reefs: Out of Sight, Out of Mind?

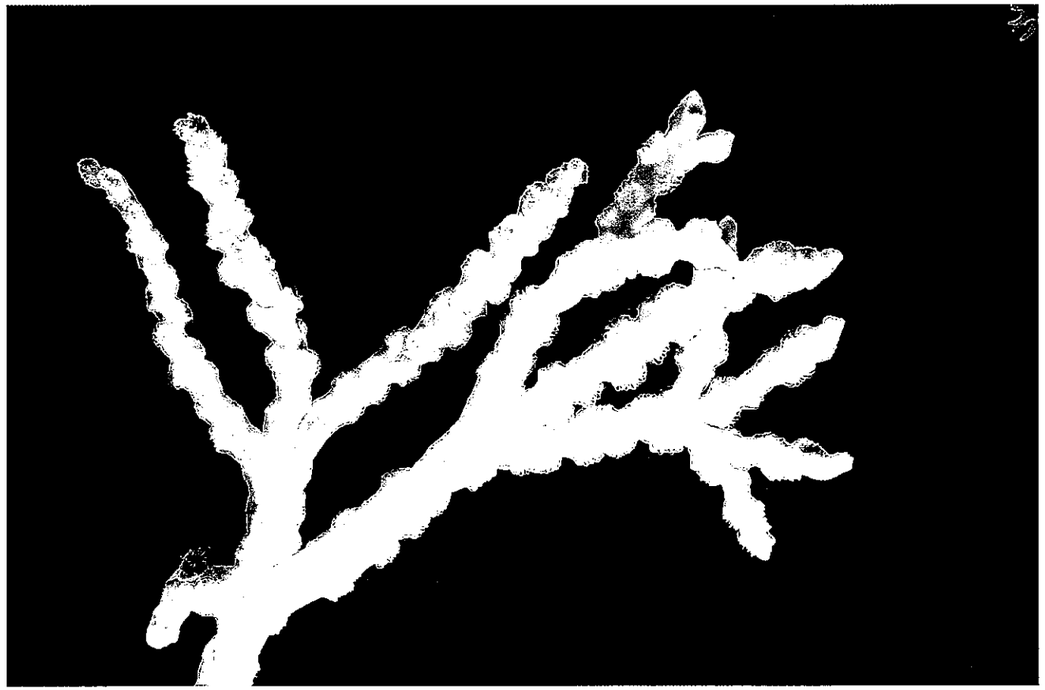
Most of the coral reefs that we are familiar with live in the warm, crystal-clear waters of the Earth's tropical oceans. Other coral systems exist, however, that are less familiar and rarely seen, but just as threatened by anthropogenic impact as their tropical counterparts[1]. These are coral bioherms that occur on deep-water topographical structures such as seamounts, shelf edges and pinnacles in most of the oceans of the world. The reef frameworks are created by ahermatypic, azooxanthellate branching corals that form roughly hemispherical colonies from planular settlement or colony fragmentation. These colonies grow larger until the internal core ceases to receive sufficient water flow and dies. The dead branches are then invaded by boring organisms and the weakened structure eventually collapses. Over time, the reef structure is formed from a substrate of unconsolidated dead coral and sediment with an outer cover of living coral.

> The deep shelf-edge *Oculina* reefs form natural spawning and feeding grounds for commercially important populations of fish

In many cases, the reef framework is a single primary species such as *Lophelia pertusa, Goniocorella dumosa, Solenosmilia variabilis* or *Oculina varicosa*[2]. Several other species may contribute to the framework, including *Madrepora oculata, Desmophyllum dianthus, Dendrophyllia cornigera, Solenosmilia variabilis,* and *Enallopsammia spp.*[2]. *Madrepora oculata* is probably one of the most widespread deep-water corals; in the North-East Atlantic it often contributes to the reef framework with *L. pertusa*[3], and in the waters around New Zealand it occurs with the major framework builder *G. dumosa*[4]. Many of the deep-water reef



Close up of Deepwater Oculina *(Photo: John Reed, Harbor Branch Oceanographic Institution)*



Deepwater Oculina *coral*

species are cosmopolitan (*L. pertusa, S. variablilis and M. oculata*), others are primarily restricted to one hemisphere (*G. dumosa*) or in the case of *O. varicosa*, exist only in a single geographic location, the Atlantic continental shelf of Florida.

O. varicosa exists over a range of depths from 4 to 150 m. The shallow-water phenotype can be found from North Carolina to the Caribbean; the colonies are small (<30 cm) with stout branches and symbiotic zooxanthellae, giving the coral a golden-brown coloration. The deep-water form of this species (70-100 m) creates continuous tracts of large branching colonies on slopes and pinnacles on the edge of the continental shelf from Fort Pierce to Cape Canaveral, Florida. There are also deep-water individual colonies reported as far north as Cape Hatteras, North Carolina[5]. The deep shelf-edge *Oculina* reefs form natural spawning grounds for commercially important populations of gag and scamp grouper, nursery grounds for juvenile snowy grouper, and feeding grounds for many other fish species including black sea bass, red grouper, speckled hind, warsaw grouper, amberjack, red porgy and red snapper. Large populations of the commercially valuable squid, *Illex oxygonius*, are observed to spawn on these reefs, and the shelf-edge system may form part of the migration pathway for king mackerel. The deep-water banks also support very rich communities of invertebrates and faunal diversity on the *Oculina* banks is equivalent to that of many shallow tropical reefs[6].

Many areas of the *Oculina* banks show extensive mortality

In 1984, the South Atlantic Fishery Management Council designated 315 km^2 (92 square nautical miles) of the deep *O. varicosa* banks as a Habitat of Particular Concern (HAPC) because of their value as essential habitat to many important commercial species. Closure to mobile fishing gear and anchoring was enacted to protect the delicate *Oculina* thickets. In 1994, the reserve was closed to all bottom fishing for 10 years, and the Experimental *Oculina* Research Reserve (EORR) was created. In July 2000, the HAPC was extended to encompass the full known extent of the *Oculina* banks, an area of ~ 1000 km^2 (300 nm^2). Many areas of the *Oculina* banks show extensive mortality, with some places the live coral having been reduced to rubble, however, the causes of the damage are unknown and open to speculation. Another mystery of the banks is the apparent lack of re-colonization of the damaged areas inside the EORR. Possible explanations may include limited larval transport, insufficient settlement substrate or local environmental influences that preclude establishment of viable colonies.

Despite the value of *O. varicosa* as a primary component of this critical fisheries habitat, nothing of the reproductive ecology of the coral was known prior to 1998. Recent research has yielded information on ecologically relevant aspects of reproduction, such as reproductive strategy, duration of breeding season, fecundity and larval longevity[7]. In 1996, a reef-restoration effort was initiated by Dr. C. Koenig (Florida State University and The National Marine Fisheries Service). Different types of artificial settlement substrate were deployed on the *Oculina* banks between 1996 and 2000 to stimulate recovery of the coral and enhance re-population of the depleted fish communities, which are dependent on the habitat. We now understand enough of the ecology of *O. varicosa* to make an intelligent attempt at restoration, however, the growth rate of *Oculina* is slow[8] and recovery of large damaged areas will not occur in the near future.

These fragile deep-water reef systems are still being discovered and information on their prevalence is almost certainly underestimated

Very little is known of the ecology of other deep-water reefs, many of which are also under threat from anthropogenic impact. The effects of fishing on the deep-sea benthos are at present generally unknown[9]. The most obvious impact of trawling is mechanical damage caused by the gear itself. Trawl scars have been seen in many of the areas off Western Scotland and Ireland where *L. pertusa* reefs occur[10]. On the Southern Ocean seamounts, trawling for the Orange Roughy fishery (*Hoplostethus atlanticus*) has reduced the reef complex to a low diversity disturbance community[11].

Apart from direct mechanical damage, disturbance of the seabed may release clouds of sediment that can smother the coral polyps and may inhibit future larval settlement. Drilling for oil deposits and mining of deep-sea minerals also pose threats to deep-water reef systems. As global over-fishing of shallow-water fisheries continues, there will be increasing incentive to exploit the deep sea. These fragile deep-water reef systems are still being discovered and information on their prevalence is almost certainly underestimated. As always, conservation is in a race against human demands. It would be a tragedy to lose these coral reefs before we can begin to understand them.

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The Mohéli Marine Park: One of the First Protected Areas in the Comores

The Comoro Islands, situated in the Mozambique Channel, are host to thousands of endemic species of flora and fauna, making it an important regional site of biodiversity. However, the high population density has subjected the environment to great pressures, such as deforestation for agriculture, and destructive fishing techniques (dynamite, small mesh nets etc.).

To address growing concerns over the environment the Comoro Government initiated a five year Biodiversity Conservation and Sustainable Development Project in 1989, financed by 'Funds for the World Environment' and administered by the General Directorate of the Environment with technical assistance from IUCN. One of the project's key objectives has been to establish a marine protected area in the costal zone of Mohéli, the smallest and least populated island of the Federal Islamic Republic of the Comoro Islands, with an area of 211 km^2 and 32 000 inhabitants.

Locally recruited 'eco-guards' help to raise public awareness, and are active in policing and monitoring the park

Both local communities and government authorities helped create the Mohéli Marine Park. Meetings and on-site visits were organized with the fishermen and the associations of 10 coastal villages. They negotiated, defined and guaranteed the sharing of duties, as well as rights and responsibilities for the management of the protected area. The input from the village meetings was then used in the park's design to define the boundaries, zoning, management and regulations. The Mohéli Marine Park was officially designated on 19th April 2001.

The coastal communities of Mohéli will continue their active participation in the management of the park with ten of the park's sixteen board members representing them. Locally recruited 'eco-guards' help to raise public awareness, and actively police and monitor the park. Each village, through their respective development associations, has also signed a specific joint park manage-

ment agreement with the Government's environmental services.

The Mohéli Marine Park covers an area of 404 km^2 and extends from the island's shore to a depth of 100 m. The coastline consists of a series of beaches and rocky areas, and scattered, poorly developed mangrove stands. A fringing reef follows the coast, and encircles seven small islands that lie opposite the village of Nioumachoi. Comoro's reefs are characterised by massive colonies of *Favia*, *Favites* and *Porites*; encrusting and foliose *Turbinaria*, *Echinopora* and *Montipora*; branched and tabular *Acropora*, *Pocillopora* and *Pavona*; and the brain corals *Platygyra* and *Leptoria*[1].

Almost fifteen years ago the most striking coral and reef fish communities of the archipelago were observed around the Nioumachoi islets. This area was considered to be comparable, although smaller in area, to reef sites in the Mayotte lagoon, western Madagascar and the Seychelles[2]. The diversity of the corals that make up the fringing reef, the richness of its invertebrate and fish fauna, and the size of its adjacent reef flats and sea grass beds (attracting turtles and dugongs) are the fundamental elements that will either make or break the sustainable development of the island[3]. More recently, in 1994, studies confirmed that the vast marine area of the Nioumachoi islets is an exceptional site of biological richness and diversity[4].

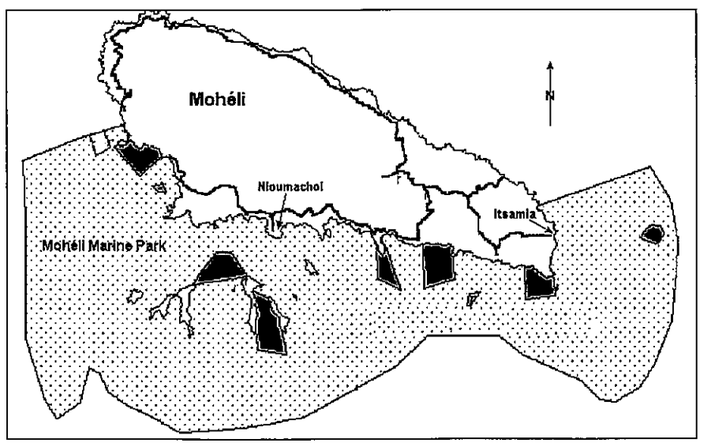
The Regional Environment Programme (COI/UE) undertook an assessment of the coral reef status in 1998. Within the park zone, living coral cover had decreased from 50% in 1994[4] to 25% in 1998[5]. The decline in coral cover was largely attributed to the bleaching and mortality that occurred throughout the Indian Ocean[6] in 1998. More recent observations, however, revealed positive signs of reef recovery. The live coral cover in the park area is now at 41%[5]. However, knowledge of the biological diversity and abundance of other reef dwelling species in the Mohéli Marine Park Zone remains very limited and to date has not been systematically studied. Reef fish research that has been conducted in the past was not exclusive to Mohéli but did reveal that of the 850 species of fish found in Comoro waters, 250 are present in the Mohéli area.

knowledge of the biological diversity and reef species abundance in the Mohéli Marine Park Zone remains very limited

Mchako ilset, located on the eastern side of the park, contains a breeding colony of several thousand noddies (*Anous stolidus*), as well as several pairs of terns (*Sterna fuscata*) and boobies (*Sula sula*, *Sula dactylatra*). The beaches within the park are also important nesting sites for the green turtle (*Chelonia mydas*) where nesting occurs all year round. An estimated population of 4,000 to 5,000 nesting females have been found on Mohéli, of which 75% are found in the park[7]. Some of the beaches on Itsamia accommodate 50 to 70 females every night at the height of nesting. Other large marine fauna that can be observed in the park include humpback whales, *Megaptera novaengliae* (July to October), spinner dolphins (*Stenella longirostris*) and a small number of dugong (*Dugong dugong*).

an important step for the Comoros toward the sustainable use of its natural biodiversity while maximising economic benefits at the local level

To ensure the sustainable use of the park's marine resources and to promote the development of ecotourism, neither speargun nor net fishing are allowed. Destructive fishing methods such as the use of dynamite and poisons are already prohibited by the Comores Legal Framework on the Environment. In fact, ten marine reserve areas (5.5% of the park's area) have been created where all forms of exploitation are prohibited (see marine park map).



Mohéli Marine Park with the 10 reserve areas where fishing is prohibited (dark shaded areas).

Agriculture is the main occupation of the approximately 9500 inhabitants of the 10 villages that are found within the park boundaries. Of these just over 300 fishermen, 70% of whom consider fishing to be their principal activity, still use traditional outrigger canoes though some have opted for motor boats.

The creation of the Mohéli Marine Park represents an important step for the Comoros toward the sustainable use of its natural biodiversity while maximising economic benefits at the local level. Much remains to be done to demonstrate the possibilities for effective local resource management and the economic benefits of conservation. However, the willingness being shown, as much at the administrative and political level as at the local level, gives much optimism for the park's success. Already after only a year the fishermen have noted a significant improvement in fish catches and the reappearance of certain species of fish.

Thanks to this commitment to environmental protection, the members of the local development associations have ensured the conservation of the Comores' exceptional natural heritage for the benefit of future generations. At the same time communities have recognised the need for continued economic development and have seen the unique potential for the development of ecotourism in not only the marine environment but in the coastal forests as well. Already three local associations can accommodate tourists in rustic but well maintained bungalows.

The international community is invited to participate in the conservation of biodiversity in the Comores by helping to enhance environmental awareness in order to guarantee the sustainable use of Comoran natural resources. Finally, without a mechanism for the sustainable financing of marine conservation in the Comores the progress made to date may be lost in the future. To address this issue a feasibility study to identify long term funding solutions is currently being undertaken.

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A Healthy Caribbean Coral Reef Assisted by Diving Tourism

The reefs of Cozumel Island, in the Mexican Caribbean, are protected and preserved primarily by the local diving industry. Approximately 15 km of coral reef attract an average of 2000 dives per day, about 320 days per year (limited by weather). Diving, along with cruise ship tourism, supports a city of about 80,000 people, with no agriculture or industry other than tourism. Over 100 dive shops currently operate in Cozumel, which along with hotels, restaurants, dive boats, taxis and curio shops, make Cozumel one of Mexico's top three foreign-exchange earning resorts. The dive and tourism industry in Cozumel is labor-intensive, and the dollars

15 km of coral reef attract an average of 2000 dives per day, about 320 days per year

earned cascade through the local economy sustaining the local community.

Cozumel fishermen discovered in the 70's that taking divers out to the reef was more lucrative than fishing, and rapidly converted their fishing boats to dive boats. This was spontaneous and unplanned. In 1980 the reefs were declared an Ecological Reserve, and in 1997 a National Park. Fishing within the park is rare, and since all operators know that fish, particularly large fish, are one of the principle draws for divers, punishment for fishing can be significant. The fish fauna includes some very large groupers and parrotfish, confirming the lack of fishing.

The Cozumel reefs boast coral species richness as high as any in the Caribbean[1] and some of the world's most spectacular sponge fauna and cavern systems[2-5]. Fish are diverse and very abundant[6,7]. The island is low and porous, with no surface runoff[8]; and has springs along the shore which release sediment-free water. The Yucatan Current brings oceanic water across the reefs before reaching the city, minimising human effects. Strong currents necessitate drift diving, so anchors do not damage the reefs. Although there is doubtless some diver damage, it is so minor that the reefs recovered from the moderate damage of Hurricane Gilbert in 1988 while receiving 2000 dives per day. The Yucatan Peninsula, about 12 km to the west of Cozumel, provides protection to the reefs which are along the southwest, limiting hurricane damage[6]. Mass bleaching has not been observed on these reefs even when most other Caribbean reefs were heavily bleached. Perhaps this is due to the currents. Coral diseases other than black band (which is uncommon) have not been observed, though *Acropora palmata* is uncommon and *A. cervicornis* is rare, for unknown reasons. Although the mass *Diadema* urchin die-off of 1983 occurred in Cozumel as well as the rest of the Caribbean, algal blooms did not result. Dense fish populations (including herbivores) and currents that sweep human nutrients away from the reefs may have been responsible for the lack of a macroalgae bloom. Black coral collecting is carried out below the 50m depth limit of the park; which is carved locally and sold to tourists[9].

A pier was constructed at the very northern end of the Ecological Reserve in 1996, next to the existing pier to accommodate increasing numbers of cruise ships. The construction area had scattered corals but no reef, though Paradise Reef was quite close. A Reefkeeper's survey and report recommended the pier be constructed outside the Reserve and away from the reefs[10]. Construction proceeded after about 20,000 corals and other organisms in the construction area were moved[11].

Cozumel reefs boast coral species richness as high as any in the Caribbean

Cozumel appears to retain one of the Caribbean's most healthy reefs, in spite of or rather because of, heavy diving use. Dive tourism can be sustainable, non-destructive, economically beneficial, and even help save reefs.

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Condylactis gigantea - A Giant Comes Under Pressure From The Aquarium Trade In Florida

Up to 30 cm across the tentacles, the giant Caribbean anemone *Condylactis gigantea* is the largest and most distinctive actinian in the wider Caribbean (Figure 1). It's known by a variety of local names, reflecting its distribution throughout the region in habitats from 1 to 30 m depth, including mangrove lagoons, nearshore hard-bottom, seagrass beds, and coral reefs. Call it what you will (condy, Haitian anemone, giant golden anemone or pink-tipped condy), *C. gigantea* is an important predator of small creatures while bigger specimens can also feed upon urchins and other sizeable prey. The condy is not without its own predators. Aeolid nudibranchs, some reef fishes, and the fireworm *Hermodice caruncullata* will eat it. A variety of commensal species, most notably cleaner shrimps of the Genus *Periclimenes,* also associate with *C. gigantea*.

An annual average of 11.8 million anemones worth US$6 million was landed from 1997 to 1999

But surprisingly, there's not much quantitative data on the distribution and abundance of *Condylactis gigantea* in the Florida Keys, even though this species and other actinians are heavily targeted by the marine aquarium trade[1,2]. Up to 400 *C. gigantea* per vessel per day is the currently permitted catch with a saltwater products license, marine life fishery endorsement, and a restricted species endorsement issued by the State of Florida. During 1990 through 1992 commercial marine aquarium collectors in southeast Florida (Palm Beach County to Key West) took an annual average of nearly 290,000 anemones (83% of which were *C. gigantea)* with most probably collected in the Florida Keys. An annual average of approximately 11.8 million anemones worth US$6 million was landed from 1997 through 1999[2]. More than 90% were collected in the Florida Keys, with fishing concentrated in state waters on the Atlantic Ocean side of the middle Keys (nearly 28.5 million individuals or 58%) and lower Keys (6.8 million or 16%), followed by state waters on the northern side of the lower Keys (767,000 or 6.5%) and middle Keys (672,000 or 5.7%). Landings in Federal waters were relatively low offshore of the lower Keys (286,000 or <1%) and middle Keys (513,000 or 4.3%). These data don't include animals taken by recreational collectors, and there is no data on species abundance patterns or population trends relative to fishing effort[3]. However, State and Federal waters off Key Largo are protected from marine ornamental fishing, as well as Dry Tortugas National Park and the 23 relatively small no-fishing zones distributed from Key Largo to Key West.

there is the possibility that the distribution patterns we observed offer dismal prospects for population recovery

We wanted to ascertain density estimates of *Condylactis gigantea* among habitat types, regional sectors, and between no-fishing zones and reference areas open to fishing[4,5]. We surveyed 102 shallow-water transects (< 15 m depth) in the Florida Keys (Figure 2) and 32 sites in the Tortugas region (Dry Tortugas National Park and the Tortugas Bank) at 4 m to 28 m depth. This work was part of a larger monitoring and assessment program looking at reef community structure and condition throughout the Florida Keys and Dry Tortugas[6]. Altogether, *C. gigantea* surveys at 134 sites in the Florida Keys and Dry Tortugas, spanning 2 m to 28 m in depth and covering over 250 km, yielded only 15 individuals, a maximum density of 0.038 individuals per m^2, with the species present at only 8% of the sites.

Do these density patterns indicate overexploitation, life history, or other factors? Like any investigation of this nature, the current data are difficult to put into perspective because of the long history of exploitation, the paucity of information on population trends and abundance, and the multitude of factors that affect population dynamics. We have not surveyed any seagrass or other soft-sediment habitats, and commercial landings data[2] suggest large aggregations may still exist in some areas. But although there isn't much basic life history information on *Condylactis gigantea* and other actinians, recruitment of sexually produced planula into natural populations is probably rare. *C. gigantea* is a gonochoric (separate sexed) broadcast spawner, has

*Figure 1. The giant Caribbean anemone (*Condylactis gigantea*) can reach over 25 cm in diameter, and has tentacle tips packed with powerful stinging cells. This species provides refuge for various invertebrates and small fishes, including ecologically important cleaner organisms. (Photo: Ed Green)*

a 1:1 sex ratio of males to females, spawns at least during the summer, and the larvae are planktonic and lecithotrophic (nonfeeding)[7]. So because many actinians have very long lived adult states, low and sporadic larval recruitment, and high juvenile mortality, there is the possibility that the distribution patterns we observed offer dismal prospects for population recovery, especially considering the intensity of exploitation in the Florida Keys[1]. This runs counter to the widely held assumption that overfishing of marine invertebrates is unlikely because of their fast growth, high fecundity, high recruitment, and hence rapid population turnover.

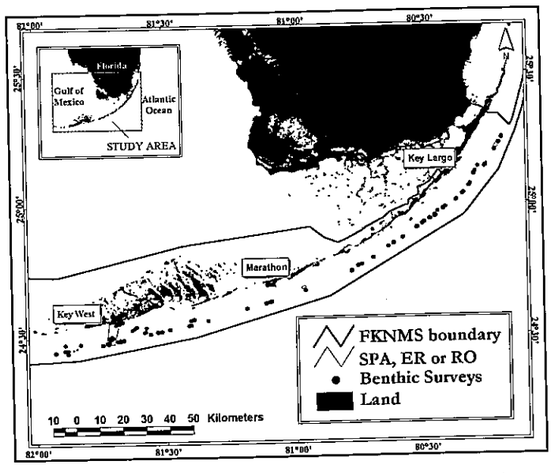

*Figure 2. Florida Keys sites surveyed by the authors for densities of the giant Caribbean anemone (*Condylactis gigantea*) during 1999-2000. Not shown are 32 sampling locations in the Dry Tortugas region, 117 km west of Key West.*

Whatever the answer, the 23 no-fishing zones in the Florida Keys National Marine Sanctuary afford a unique opportunity in south Florida to evaluate fishing effects[3] (also see **News**), not only for the most economically important species[1], but also for a diverse assemblage of exploited, but relatively understudied species. Density data for *Condylactis gigantea* provide one baseline to measure the responses of the population to protection from fishing against, but they could also help us understand some of the indirect effects of fishing, such as altered habitat availability for cleaner shrimps, and the behavioral change of reef fishes to changes in cleaning station density. Effective fisheries management requires information on how fishing effort varies spatially, target species population trends, and life history parameters such as growth, recruitment, and mortality. Appropriate sampling can provide fishery-independent density and total abundance estimates. When coupled with the important data generated through the fishery itself (e.g. number of vessels, fishing days, landings, CPUE), state and federal resource managers could gather the information they need on population estimates and trends relative to fishing effort.

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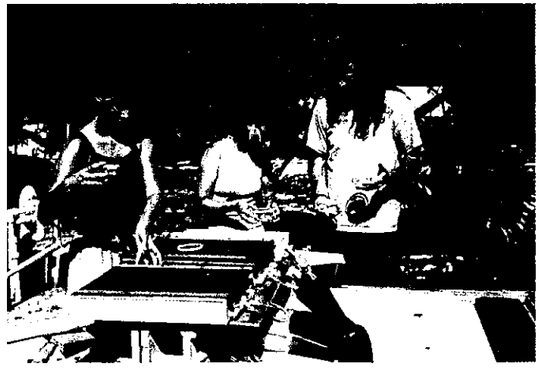
Undergraduates In Research

Can undergraduates do worthwhile science? Yes - with good planning you can get high quality data. What you need is a programme explicitly designed to include undergraduate students as research partners. Research at the Western Washington University's Shannon Point Marine Center and at the Caribbean Marine Research Center in the Bahamas has been doing just that. Our work focused on how zooxanthellae in corals and tropical anemones respond to high irradiance (UV and Photosynthetically Active Radiation) and high temperature stresses. A total of 18 students over three years helped study changes in animal-algal biomass parameters and photosynthetic performance of zooxanthellae, changes in photosynthetic pigments of zooxanthellae, and changes in the optical spectra of symbiotic associations during bleaching.

with the lure of coral reefs you'll attract the best students from any discipline.



Students sampling corals from our experimental treatments, Caribbean Marine Research Center, Bahamas, summer 1999.

What do undergraduates bring to research? For a start, the pool of potential researchers is usually large, and with the lure of coral reefs you'll attract the best students from any discipline. You're also likely to find greater ethnic and cultural diversity, widening opportunities for these groups in science careers. You can often include future teachers who rarely get to do research during their training. Undergraduates may even help you target funding. In our National Science Foundation (USA) funded work, involving undergraduates leveraged the funds for our research. And because the grants provided financial support, no potential student was excluded. Our students were paid full-time during the summer and part-time during the following academic year. By including undergraduate partners you meet funding agencies' and scientists' needs to address human impacts and broaden the educational significance of research.

Which students should you target? We decided we needed a 12-month commitment from each student, so they had to have at least one year left at college. This meant they could participate full-time in summer research and work on data analysis and

project presentation the following year. This gave us the maximum number of participants, although the research might have benefited more from smaller numbers involved for a longer time. For effective fieldwork you need a solid foundation course *before* going to the field. We began each year's summer research program with two-weeks of intensive introductory workshops covering record keeping, data management, analytical methods, experimental design, and background to the research problem. Each student learned to enter information into their own laboratory notebook in a consistent format that would allow us to successfully retrace methods and potential errors years later.

> ...the realization that, for the short time spent on the reef, many months were spent doing tedious and repetitious work!

We used the symbiotic sea anemone *Aiptasia pallida* to demonstrate methods for studying photosynthetic pigments, zooxanthellae cell counts, protein analysis etc. We ran seminars on algal symbiosis, coral reef ecology, and remote sensing and ocean optics. Students prepared specialist topics with their mentors, who also supervised the write up in the following year.

> you need a solid foundation course before going to the field

This valuable training investment ensured high quality research efforts from all students. The introductory workshops build a close-knit team that worked effectively under a very intensive research schedule in the field. The fieldwork had to be well organized to manage data sampling while staying flexibile enough to re-adjust the plan around unpredictable obstacles. We also carefully rotated tasks so everyone shared the fun work (SCUBA diving on the reef) and the laboratory work (e.g. filtering large numbers of samples).

In the writing-up year, students worked more closely with their mentors than with the team, but still met weekly to discuss research issues and present progress reports, including a poster or talk (which became their final project product). Many students got academic credit from their departments for their work, for example two science education majors developed an educational curriculum for high school teachers using *Aiptasia pallida* as a research subject. All students presented their posters at a regional or national conference, and two presented their work at the 9th ICRS conference in Bali, Indonesia. In follow-up questionnaires, all rated their experiences highly for career preparation and exposure to 'real science' (the main negative was the realization that, for the short time spent on the reef, many months were spent in the laboratory and on the computer doing sometimes tedious and repetitious work!).

There were some drawbacks, such as a slower than typical publication rate, and the challenge in managing the trade-off of a student's freedom to be innovative and independent against the rigorous quality control needed to get publishable data. Both students and faculty had to invest a lot of time, and this extended into the academic year when other obligations were pressing. We tackled this by hiring one of our first students as a full time technician after her graduation - it was the best decision we made. With good financial and institutional support, the time commitment for faculty was less of a personal sacrifice.

By involving undergraduates we met both our research and education goals. Several of our students are now doing graduate studies. Others have jobs that rely on the skills they acquired. Having undergraduates from a variety of disciplines working together promoted inter-disciplinary communication and partnerships between scientists, teachers, and others. Ultimately, this type of interactive research with undergraduate students should lead to better public understanding of the value of scientific research.

Gisèle Muller-Parker
(Email gisele@biol.wwu.edu). Other academic supervisors were S. Strom and J. Hardy. You can find out more about the research at: www.ac.wwu.edu/~gisele/searun2.htm

Seeking Sustainable Solutions: Fishing And Coral Reefs

A Statement From The International Society For Reef Studies[1]

*Earlier this year **ISRS** was asked to prepare a statement on sustainable reef fisheries for the International Coral Reef Initiative.*

Coral reef fisheries have an important place in many human societies. But problems of unsustainable fishing are commonplace, and their detrimental social and ecosystem consequences can be far-reaching. Sustainable solutions are a major challenge.

The vision: sustainable fishing for food security and other benefits

Sustainably fishing diverse coral reef species could open up many economic opportunities for local communities, businesses, and government administrations. Sustainability, which can be measured by long-term reliability of stocks, protection of the coral reef habitat, and avoidance of detrimental cascading ecosystem effects, can also protect other properties of coral reefs that are of great value to humans. In particular, sustainable fisheries can:

a) Contribute to food security and to the cultural, social and economic fabric of local communities;
b) Make money through nature-based tourism and diving revenues. These revenues are highest from beautiful and diverse coral reefs that retain abundant fishable species – some species may be worth more alive than dead. Well regulated fisheries or aquaculture for the aquarium and curio trades can also generate wealth;
c) Save money by having healthy, growing nearshore coral reefs that protect the coast and remove the need for expensive beach restoration projects (the cascading effects of chronic overfishing can flip a reef barrier from a state of net growth to net erosion).

The problem: unsustainable fishing undermines food security and ecosystem processes

1. Many reef-based fisheries across large expanses of the tropics have disappeared or become severely diminished under pressures from both local populations and distant markets. Predatory fish, which are vulnerable to most fishing gears, usually disappear first. Fishers may take fish before they reach their most productive size (Growth Overfishing). Intense exploitation can drive numbers so low there are not enough individuals to maintain a viable population (Recruitment Overfishing). This can in turn cause a progressive shift in the balance of species on the reef (Ecosystem Overfishing) and distort the trophic pyramid, i.e. the natural balance of energy flow from the bottom to the top of the food chain. Some fishing techniques, such as dynamite and cyanide fishing, harm the reef and the complex environment fish and other creatures need to survive (Destructive Fishing).
2. Scientific evidence shows that when unsustainable fishing decimates the trophic pyramid, ecosystem-wide declines over large areas of coral reefs can occur, including more frequent incidences of:
   a) Under-grazed reefs, where seaweeds preempt space formerly occupied by corals, and prevent coral recovery after natural or anthropogenic disturbance;
   b) Over-grazed reefs, where an overabundance of invertebrates that graze by scraping food from the reef (notably sea-urchins), erodes reef structure much faster than it accretes;
   c) Over-predation of live corals, by invertebrates such as crown-of-thorns starfish and coral-eating gastropods.

Unsustainable fishing in concert with other anthropogenic pressures

3. Detrimental effects of unsustainable fishing are exacerbated by other anthropogenic pressures such as land-based pollution by sediments, fertilizers, sewage, toxins and trash.
4. Unsustainable fishing may itself exacerbate the poorly understood, ecosystem-wide impacts of coral bleaching and diseases of coral reef organisms[2]. The future extent, frequency and intensity

continued on page 52

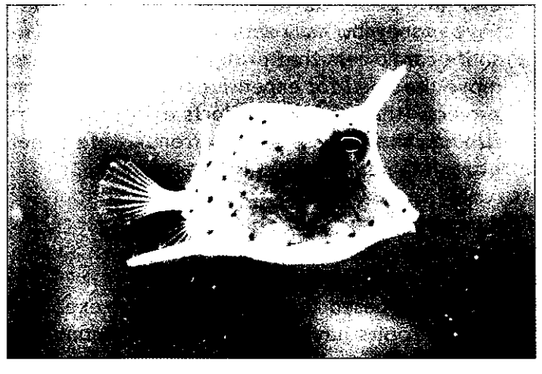
FEATURE

Juveniles Recruited to Sustain Aquarium Industry

*A settlement stage yellow tail snapper (*Ocyurus chrysurus*) hovers amongst seagrass (Photo: Maggie Watson).*

The chances of a fertilized egg making it all the way to become an adult reef fish are exceedingly small. Now researchers want to side-step some of that mortality in order to supply a sustainable aquarium trade and, at the same time, conserve coral reefs.

A damselfish swimming amongst the corals and rocks in a well kept aquarium seems a serene enough creature, but a few rough calculations will leave you marvelling at a journey of survival against tremendous odds. Now don't leap to conclusions about the villainous aquarium trade - the journey from reef to aquarium is only a small part of the tale. To begin with, unless our fish is one of only around 25 species of marine ornamental fish bred in captivity, it started life as a tiny larvae developing in open water. The vast majority, i.e. approaching 100%[1] of larvae, will perish before they return to shallow water. Then, often timing their arrival to the darkest nights of the month to avoid visual predators, the minute fish must negotiate a 'wall of mouths'[2] before settling to the bottom. Survival rates will vary, of course, both between species and over time. But for the few that make it to the end of their pelagic (open water) phase and then through the settlement process, around two thirds may die within a day of settlement[3]. After a month only 10% of the fish that settled may remain alive[3]. Those kinds of numbers have set researchers thinking - if you could harvest just a few fish before they meet their 'mortality hurdle' at settlement, your fishing impact should be minimal.



This tiny cowfish Lactophrys *spp. is only around 2cm long (Photo: Maggie Watson).*

*Blue tang (*Acanthurus coeruleus*) are yellow as juveniles. This fish settled less than 24 hours previously, and is still partly translucent (Photo: Maggie Watson).*

Baby fish aren't much good for eating, but juveniles are preferred by the aquarium trade. They cost less to ship, and they are often prettier than the adults. Researcher Vincent Dufour is so sure that there is a market that he has set up a company, AquaFish Technology (*www.aqua-fish.com*). Dufour found that 'crest nets' (shaped like funnels which catch the waves) set on reef crests around Pacific atolls will filter huge amounts of water flowing over the reef and through the lagoon. They can catch thousands of larval reef fish during a big settlement pulse. In one crest net on Moorea Atoll, Dufour's team averaged over 100 fish per night, many of which were ornamental species[4].

Aquafish hopes to contribute to a sustainable aquarium fishery, and Dufour and colleagues are not alone in thinking the idea has merit. Cathy Hair, Johann Bell and colleagues at the Coastal Aquaculture Centre in the Solomon Islands (run by ICLARM – The World Fish Centre) have been looking into village-based 'grow out' of larval fish. The idea is to provide coastal people with an alternative livelihood, and hopefully relieve some of the fishing pressure on coral reefs. Between November 1999 and June 2000 the team caught more than 1,170 fish from 70 species that were suitable for further rearing in on-shore tanks supplied with flowing seawater. The team use both light traps, based on designs developed in the 1990s by Peter Doherty at the Australian Institute of Marine Science (AIMS), and crest nets. The two methods both have their advantages. Light traps caught fewer kinds of fish than crest nets but more damselfish (Pomacentridae), many of which are ornamental species.

Sadly, ethnic violence in the islands has slowed research. Hair, an Australian, was evacuated in June

*Settlement stage filefish (*Monacanthus *spp.) like to hang out around weed or other floating objects. The water here is so still you can see their reflections (Photo: Maggie Watson).*

last year and spent the next six months working up data at AIMS, where Doherty is a collaborator on the current phase of the project. Some research by local Solomon Islands staff has continued, but the constraints imposed by the political situation are frustrating real progress.

Before the troubles began Hair and colleagues were feeding their fish on eggs (roe) from a variety of large fish, on creatures the fish picked from live rock, on plankton that came through the seawater pump, and on prepared food supplied by Mike Rimmer of the Queensland Department of Primary Industries. Damselfish, surgeonfish, snappers and triggerfish were all easy to rear. Painted cray *Panulirus versicolor* showed promise once cannibalistic individuals were isolated, and the delicate cleaner shrimp *Stenopus hispidus* also showed potential for rearing. But early juveniles are notoriously picky eaters and some families such as butterflyfish did not take well to the tanks.

About the same time, John Munro and colleagues (including the authors) were working on another ICLARM research project investigating larval fish

supply to islands in the Eastern Caribbean. When gluts of settlement stage snapper larvae were caught in light traps (up to 407 yellowtail snappers *Ocyurus chrysurus* in one light trap in a single night), Munro suggested keeping the fish in floating cages, illuminated at night by submersible lights. The lights would attract plankton for the fish to eat. The experiment was a first tentative step towards investigating the feasibility of helping restock new marine protected areas. The idea was that where previously overfished reefs suffer severely reduced natural recruitment, light trap caught larvae or juveniles could be reared in cages for several weeks. Once past their 'mortality hurdle' they could be released to help rebuild stocks. Whether the idea will work is still far from clear, and the team continues to investigate relative mortality rates in the wild and in captivity, feeding preferences, behaviour on release, etc. But several advantages were immediately apparent from the research. Floating mesh cages are cheap aquaculture tanks, and you don't need expensive equipment to maintain water quality. Plankton, much of which is attracted to light, is the natural food of many early juvenile fishes. Perhaps this low-tech approach would also be useful for village-based 'grow out' of fish larvae for the ornamental trade?

> don't leap to conclusions about the villainous aquarium trade

We experimented with solar powered and shore-powered lighting for floating fish cages, but waterproofing the lights can be tricky and expensive, and each floating cage needs a separate light. Biofouling can also clog the fine mesh needed for small fish, and exclude the light. Our most promising development is a simple 'plankton pump' (designed by Robert Power) which uses a single light to attract plankton at night, and then utilizes the same principle as the air lift pumps seen in many aquaria to circulate fresh, plankton rich water to floating cages or to tanks on nearby land. Alternatively, plankton rich water can be diverted to holding tanks, and fed to the fish the following day – so the natural cycle of day and night can be maintained for fish that use sight to catch food. So far, survival and growth rates have been promising for the snappers that we caught[5], and also for surgeonfish, filefish, damsels, butterflyfish and lobster larvae.

> harvest just a few fish before they meet their 'mortality hurdle' and your fishing impact should be minimal.

To make such 'grow-out' techniques more accessible to poor communities, we have also tried to reduce the cost of the light traps needed to catch the fish in the first place. Traps designed for scientific research are usually prohibitively expensive. We developed modular light units which are easily swapped between traps and are easier and cheaper to fix when they go wrong[6]. And together with Steve Simpson (now studying at AIMS), we investigated building the bodies of traps from five gallon buckets studded with funnels adapted from transparent drinks bottles[6]. The traps may not be quite as efficient as the expensive versions, but they cost a fraction of the price, and they do catch fish.

So is the idea of growing-out larvae for the ornamental fish trade viable? With the 'farm gate' prices of many ornamental fish starting at around $0.50 US for the more common species[7], trading 50 individuals from common species per month would still provide more money than many dynamite fishers make[8]. However, there are still plenty of drawbacks. For example, the most valuable species in the ornamental trade are usually the rarest, and these are not likely to be the species caught in great numbers in either light traps or crest nets. And in some parts of the Pacific very small fish, called tinies, fetch up to 30% less than adults. More importantly, supply of larvae is likely to be highly unpredictable in space and time. If collectors depend on ornamentals for their living they could be driven to destructive fishing techniques such as cyanide fishing when catches of larvae are low. The best way round this would probably be to use a wide variety of species and to make this kind of aquaculture just one part of a diverse livelihood. Most importantly of all, any fishery - even for tiny fish - will still need to have its fishing effort managed to avoid overfishing. Considering the patchiness of larval supply, it's not difficult to imagine batteries of light traps and crest nets making a substantial impact on natural populations, particularly if big settlement pulses are intercepted.

> trading 50 individuals from common species per month would still provide more money than many dynamite fishers make

But, bearing in mind the colossal mortality rates for early juvenile fish, if a proportion of the reared fish were released to the wild as larger, less vulnerable individuals, the overall survival rate might still be higher than it would be without intervention. This remains an untested idea, but studies are currently underway. At least rearing natural stock provides some incentive to look after the environment, unlike more conventional captive breeding. If 'grow-out' can be made sustainable and profitable it could help both people and reefs. Farming reef fish larvae could be like selling corn seed for the price of the eventual harvest!

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Maggie Watson and Robert Power worked together on ICLARM's Caribbean Marine Protected Areas Project in the British Virgin Islands. Their emails are Maggie@xpertext.com and rpower@surfbvi.com

REEF BRIEFS

Ancient Overfishing

We think of overfishing as a modern scourge, but new research suggests even the original Native American inhabitants of the Caribbean outpaced their resources. Steve Wing from the University of Otago in New Zealand and Elizabeth Wing of the Florida Museum of Natural History investigated middens (household garbage dumps) from five Caribbean islands inhabited during the Ceramic Age. The researchers identified the ancient catch by comparing bones with modern reference skeletons. They then worked out the relationship between bone measurements and fish weights in order to estimate size. Between the early (1850-1280 years BP) and the late (1415-560 years BP) settlements, remains of reef-dependent parrotfish, surgeonfish, snappers and groupers got smaller at all sites. But open water fish (such as jacks and herrings) didn't seem to change. At several sites these pelagic fish came to dominate the catch, suggesting the fishery had moved offshore. The researchers also used mean trophic level analysis which combines fish biomass and position in the food chain to give an overall picture of the catch. Over time, they found a significant shift away from top-level carnivores towards omnivores and herbivores -a switch that is characteristic of overfishing on many reefs today.

Wing, S.R. & Wing, E.S. In press. Prehistoric fisheries in the Caribbean. Coral Reefs.

Fish That Eat Fish That Eat Fish

The leopard grouper (*Plectropomus leopardus*) is a voracious hunter, preying on at least 20 different families. But surprisingly, it doesn't take advantage of the bonanza of juvenile reef fish settling to the Great Barrier Reef during each summer recruitment season. On the contrary, it may even improve juve-

nile survival! Jill St John from James Cook University Australia examined stomach contents from more than 700 fish speared over summer, winter and spring months and found that despite the seasonal influx of small fish, *P. leopardus* took the same size prey throughout the year. The only prey items that showed seasonal variation were lizardfish (Synodontidae), which themselves eat newly settled fish. The leopard groupers took more lizard fish during the summer than in the winter and although a restricted sample size makes interpretation tentative, St John found that lizard fish in the stomachs of leopard groupers often had partially swallowed fish in their jaws, suggesting they were caught while concentrating on their own meal.

St. John J. In press. Temporal variation in the diet of a coral reef piscivore (Pisces: Serranidae) was not seasonal. Coral Reefs.

Threshold Temperatures Challenged

When it comes to predicting bleaching, threshold temperatures are not very meaningful to either corals or humans say William Fitt and colleagues in a review in Coral Reefs. If only it were that simple! Bleaching can be caused by solar radiation as well as or even instead of temperature, and is complicated by other factors such as the length of exposure and underlying seasonality. Corals can lose half their algal symbionts before a human can see a colour change. And even when corals look white they can retain as much as 20-50% of their original algal population, with many of these symbionts still in good health. So using visible bleaching to indicate an upper thermal limit for survival doesn't tell us what is actually going on in corals and their symbionts. Fitt and colleagues provide a framework for interpreting thermal tolerances and thresholds while showing how sublethal effects are related to other variables when considering the physiological limits of corals.

Fitt WK, Brown BE, Warner ME, Dunne RP In Press. Coral bleaching: interpretation of thermal tolerance limits and thermal thresholds in tropical corals. Coral Reefs.

Going Against The Flow

Researchers have been underestimating how far larval fish can swim, because until now food has not been provided in sustained swimming experiments. Small larvae, such as *Amphiprion melanopus* (only 5.5 to 7.6 mm standard length) can't store much fuel - but allowing them to feed increases the maximum distance they can swim from 11.8 to 28.7 km. Rebecca Fisher and David Bellwood of James Cook University, Australia fed *A. melanopus* brine shrimp nauplii regularly during six-day experiments in which the fish swum against a current at 7 cms^{-1} (about half their top speed). During the experiments, which began seven days after hatching, fish metamorphosed and developed juvenile coloration. Fed fish gained weight at 10.5% per day, and were strong swimmers. But unfed fish couldn't maintain their positions in the current at the end of the experiments. We already know that large larvae, such a surgeonfish larvae, can swim many tens of kilometers without food. They can carry enough energy reserves for such marathons. Now this new research shows that with enough food, sustained swimming may not be too much of a strain even for small larvae.

Fisher R. & Bellwood DR In press. Effects of feeding on the sustained swimming abilities of late-stage larval Amphiprion melanopus. *Coral Reefs.*

Bleaching Toll on Filefish

The 1998 bleaching event may have wiped out a local population of the long-nosed file fish *Oxymonacanthus longirostris* in Okinawa, Japan. These coral eating fish, which are less than 10 cm long, depend on acroporid corals where male and female fish share a feeding territory during the summer breeding season. Researchers Kokita and Nakazono from Kyushu University, Japan recorded fish growth and survival in 1997 and again during the 1998 bleaching event which devastated their study site. Many filefish disappeared immediately after the bleaching, and in March 1999 no juvenile young or adult fish were seen in the study area. *O. longirostris* show strong site fidelity, and even on the outer reef, where bleaching had been less severe, numbers were low, so Kokita and Nakazono conclude the fish died. The numbers of coralivorous butterflyfish also declined, but those populations did not disappear, suggesting the long-nosed filefish was hardest hit.

Kokita T & Nakazono A. In press. Rapid response of an obligately corallivorous filefish Oxymonacanthus longirostris! *(Monacanthidae) to a mass coral bleaching event. Coral Reefs.*

Grazing the Dead

Eating fragments of dead organic matter and the microorganisms growing on them may be as nutritious as grazing algae. Researchers Purcell and Bellwood of James Cook University tested detritus at windward sites on Lizard Island, Great Barrier Reef, and found higher nutrient levels than in associated communities of small algae growing on dead coral. Many roving and grazing fishes may get some, or in some cases most, of their nutrients from detritus. It may even be more digestible than algae if the chemicals plants make to deter grazers have broken down. But detritus didn't accumulate much on windward reefs. So unlike freshwater systems, where fish must balance an abundant supply of detritus against its generally poor food quality, detritivores on reefs may face a trade-off between high food value but scarce supplies.

Purcell SW & Bellwood DR In Press. Spatial patterns of epilithic algal and detrital resources on a windward coral reef. Coral Reefs.

Papers précised by Maggie Watson

SPYHOPPER

This article is of a Conferential nature...

Have you missed him? Have you? Well worry no more - Spyhopper is back, and feeling refreshed by a little break in the sun. Spyhopper writes from his hotel room, looking out over the glorious view of Cobanahapegelica beach. It is Session 6 of the XVIth Cerulean Conference of Spicule Studies. Or if, like Sphopper, you were out most of the night at the Discotheque (Ed – Club to the younger generation), it's a rest morning.

Absolutely amazing things, spicules. For example, did you know that the universal mean size of a spicule is, without exception, 2709 times the length of the nuclear radius? And that if a spicule were an insect of approximately ant-size, it would be capable of supporting a structure of the weight of the Chrysler building? No, neither did Spyhopper. Of course, the likelihood of using any of these amazing facts is about, oooh, nil. But that doesn't matter, because Spyhop is having a fabulous time.

Conferences - for Spyhopper they're a chance to catch up with old friends, have a few drinks, perhaps fall into the Pool in a hilarious manner that will be recounted for years to come, probably embarrass himself by making a pass at someone he shouldn't (or wouldn't normally anyway). After all, why spend money on a first class ticket to a far flung conference venue, throw money hand-over-fist at the recommended hotel, and dine in expensive restaurants if the objective is to do some work? Blimey, Spyhop can do that at his humble desk!

And this venue is certainly conducive to relaxation. The lecture theatre is a work of art, and the poster presentation area is rather fabulous. The programme has that wonderful 'shiny paper' smell and goes into considerable detail about the history of the Spicule Society and its founder, Arthur Poole who, as it turns out, was related to Charles Darwin through a series of bad marriages and good fortune. Very, very interesting story indeed... Did Spyhop mention the coffee? Simply divine- and served with those dainty little pastries that melt in the mouth. Just the thing to remedy the most appalling hangover.

Yesterday was 'excursion day'. The delegates got an air-conditioned tour of the finest sights on this lovely island. Unfortunately Spyhopper doesn't recall many details. By the time he got to the conference centre the curative pastries were gone, and he only just secured the last seat on the bus –over the back wheel which in turn went over every pothole on the road. Thankfully Spyhopper recovered in time for the plenary barbeque. The traditionally pit-roasted boar was exceptional, and the band first-rate.

But just then Spyhopper was accosted by a suspiciously young looking man brandishing a clip-board. Spyhopper was so mesmerised by the fellow's shirt – printed with an intricate design of spicules – that he failed to perform his trademark eyebrow flash and raised glass salute in time to justify a brisk shamble towards a fictitious acquaintance.

Trapped! And By Jove, the fellow had a petition! Spyhopper had to concentrate, but it seemed to be a plea to hold conferences in more accessible places at lower prices. The youth even decried the combustion of non-renewable carbon based pollutants (he must have meant propellants – his accent was a little thick) expended during the three days of travel to Cobanahapegelica.

Trying to lighten the conversation Spyhopper remarked that he hadn't met the young man previously, and proffered his breathtakingly beautiful business card. His reward was a rather indiscreet reference to the relative locations of the main auditorium and the conference bar (at the opposite end of the conference centre) followed by a jib comment about 'break-out' sessions continuing well into the night. Break Out sessions? Spyhopper considered suggesting that if the fellow wanted exercise he should try the Discotheque, but thought better of it. Instead, he proffered the undeniably well reasoned argument of mature years – Flamboyance Fosters Political Recognition. It is one's duty to endure the twinges of guilt in order to boost the cause of spicules in the national consciousness of the host nation. And anyway, why not have a bit of fun?

Thoughts anyone?

BOOK REVIEW

Oceanographic Processes of Coral Reefs:
Physical and Biological Links in the Great Barrier Reef
Edited by Eric Wolanski (2001) 356 p. ISBN 0-8493-0833-X. CRC Press LLC. (with CD-ROM) US$100/£67

Non-coral reef scientists are often shocked that we don't have reasonable answers to many questions that are obviously important for coral reef management. Aside from the fact that we don't know where most coral communities are or how humans affect them[1,2], very few multi-disciplinary scientific studies have been conducted at scales of space and time that are appropriate to guiding the management of major reef systems[3]. This situation is changing, albeit gradually, and the country in the lead is Australia.

Oceanographic Processes of Coral Reefs is a collection of 20 high-quality chapters by well-known researchers, centered on the interplay among physical and biological processes governing the function of coral reefs, mangroves and seagrasses. Some chapters, such as the two on terrestrial impacts on the Great Barrier Reef (GBR), are focused on the particular situation in GBR management, and will be of interest to those working in the area or those wishing to compare these processes with situations elsewhere. Other chapters, such as "The Effects of Siltation on Tropical Coastal Ecosystems" by Miguel Fortes, are very useful reviews of recent research, applicable to any tropical coastal situation. Perhaps because my own focus is coral reefs I was astounded to discover the importance of crabs to mangrove forests outlined in "Water Circulation in Mangroves and Its Implications for Biodiversity" by Eric Wolanski and six co-authors. The next time I visit a mangrove where I don't have to slap mosquitoes, I will wonder about how long it will take before the insecticides kill the mud crabs whose burrows flush salt from Rhizophora tree roots and gradually change the vegetation.

The next time I visit a mangrove where I don't have to slap mosquitoes, I will wonder about how long it will take before the insecticides kill the mud crabs whose burrows flush salt from *Rhizophora* tree roots and gradually change the vegetation

Linking physical and biological processes into a useful management context generally requires simulation models, and as an introduction to this area, the book excels. There is a considerable body of information presented on the relationships among currents, nutrients and coral reefs along the GBR that has been revealed through interactions among models and fieldwork. There are fascinating studies showing that large-scale longitudinal currents pump water and nutrients up through the GBR from the deep open ocean. There are also intriguing demonstrations of the major differences one would expect in the settling of fish and coral recruits on one side versus another of a reef because of current patterns. A chapter by Laurence McCook and others includes a landmark effort to model the shifting between coral and macroalgal dominance on reefs in response to nutrient inputs. They relate this on a large scale to the potential future of the GBR given various land-use scenarios. In these exercises, the superb animations on the enclosed CD-ROM are at least as informative as the chapter itself. In fact, the CD-ROM alone would more than justify the purchase of the book, as the multitude of dynamic illustrations it contains can be of immense value in explaining complex ideas to students, scientists and policy-makers alike.

valiantly dispels the myth that the political climate is ready to guarantee long-term protection of the ecosystem

All of the more than 100 countries around the world that are responsible for coral reefs have a long way to go before they can adequately meet that responsibility. Australia has made a serious attempt to work out the taxonomy of several key reef species, to find, map and evaluate its coral reefs, and now to integrate biological and physical processes as outlined in this book. Of course, natural resource management is the altering of *human* behavior to maintain ecosystems, based on a knowledge of both the natural and anthropogenic systems. A chapter by Ian Dutton provides an interesting overview of the complexities of coral reef management in Indonesia. The book ends with Frank Talbot asking "Will the Great Barrier Reef Survive Human Impact?", a chapter that valiantly dispels the myth that the political climate is ready to guarantee long-term protection of the ecosystem.

Where to go next? In a recent presentation at the University of Miami, Eric Wolanski described the need to build more integrative large-scale models to provide better guidance for managing Australia's coastlines. As he put it, we need to know how planting mangroves along a particular river will affect the resilience of a coral reef on the outer shelf. This is a noble effort, and one to which the scientific coral reef community should aspire in general. However, we will also need to know which socioeconomic group will gain or lose what by planting such a mangrove versus alternative interventions. So, I look forward to a future book summarizing biophysical-socioeconomic models and processes affecting the Great Barrier Reef. Meanwhile, I highly recommend the current book to anyone struggling to understand the complexities of coral reef and adjacent environments.

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Carbonate Platform Systems: Components and Interactions

Insalaco E, Skelton PW, Palmer TJ (2000) Geological Society Special Publication No. 178, Geological Society Publishing House, 240 pgs, ISBN 1862390746 US$85/£60

Three years (& twenty nine special publications) after "*Carbonate Ramps*" from editors Paul Wright and Trevor Burchette, we have "*Carbonate Platform Systems: components and interactions*", edited by Insalaco, Skelton and Palmer, a volume which arises from the 1999 Lyell Meeting on "*Organism-environment feedbacks in carbonate platforms and reefs*". The emphasis on interactions and feedbacks here was felt by the editors to be timely in view of the rise to prominence in recent years of Earth Systems Science. If, like many people, you've never really been sure of what Earth Systems Science is exactly, you may be interested in the Penn State Earth System Science Center (est. 1985) web-site definition: "The multi-disciplinary search for links between the Earth's physical processes and past and future global change" involving "extensive research related to the global water cycle, the biogeochemical cycles, Earth System history, and human impacts on the Earth system". If, on this basis, you are eagerly anticipating a volume that brings together research articles from right across the academic disciplines from theoretical physics through biogeochemistry to environmental economics then you will be disappointed. This is, after all, a Geological Society Special Publication and the contributing authors are almost exclusively affiliated to geology or geography institutions. This is not to say that the research articles therein do not have multidisciplinary elements because students of carbonate sedimentology will be quick to tell you that in carbonates more than any other sedimentary system, physical processes are overprinted by biological and chemical processes. It is merely to say that "*Carbonate Platform Systems: components and interactions*" is more Carbonate Platforms and components than Earth system interactions. In other words, expect a collection of geological case studies and perspectives to dip into rather than a tightly knit thesis and cover-to-cover read. Non-geologists may be somewhat disinclined to dive in because these are more "ancient" than "modern" waters, but the editors argue that the very diversity of the examples discussed in the volume illustrates the chaotic tendency of complex systems to yield contrasting results according to differing biotic and environmental conditions.

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The volume is divided into two parts. Part-1 is titled "community level processes and products" and of the things that caught my attention it is worthwhile highlighting some typically careful Cretaceous rudistid sclerochronological work by Steuber that yields useful quantitative information on $CaCO_3$ production rates. There is also an interesting account of palaeoecological changes in carbonate bioerosion over geological time from Perry and Bertling, although the causes for these changes remain obscure. Those interested in things PreCambrian will be drawn to the petrographic case study of South African oolitic and stromatolitic sequences by Wright and Altermann. At the other extreme of geologic time, those concerned with modern day coral bleaching and El Niño-Southern Oscillation will turn to Glynn's contribution. The latter is grouped into the vaguely titled "Larger scale aspects Part-2" together with the latest in a series of papers by Gischler & Lomando describing growth of Quaternary sequences in Belize. If you are looking for a controversial read, you might enjoy the paper by Kiessling Flügel and Golonka. This study attempts to calculate relative carbonate production rates by reefs through Phanerozoic time and concludes that either the controls on reefal production are too complex to allow reliable predictions, or biotic factors represent more important controls than physico-chemical parameters. All in all, an eclectic collection from which to pick and mix. At £60 (Geological Society members £40) this is one that you will probably like to see in your institution's library rather than see as a must for your office shelf.

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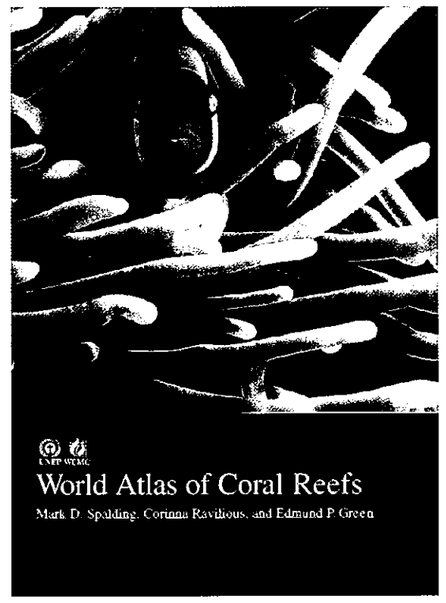
World Atlas of Coral Reefs

Mark D. Spalding, Corinna Ravilious and Edmund P. Green (2001) UNEP-World Conservation Monitoring Centre/University of California Press, 424 pgs, ISBN 0-520-23255-0 £30/US$45

A coral reef 'atlas' has been on the cards for many years, and it is good to see such a volume now in print. Less of an atlas than a 'compendium' of information on reefs, this is a handsomely illustrated publication, containing a wealth of information. Produced with the support of UNEP, ICLARM, NASA, the Aventis Foundation, PADI, the Marine Aquarium Council, ICRI and the Dulverton Trust, it attempts to make the difficult marriage between a popular reference work and something that will also appeal to scientists.

a new calculation of total area of reef – now estimated at 284,300 km²

Part I provides a general introduction to coral reefs, and is not so different from that found in many of the other semi-popular or popular books on reefs published over the last decade. Parts II –IV are the main meat of the atlas and consist of the regional and country reviews, comprising various maps as well as general descriptive text.



The maps are the focus of the publication. The introduction gives the impression that reef mapping dates only from 1994, but Chapter 3 provides an interesting discussion of reef mapping, referring to earlier work from Darwin onwards, on which the atlas maps have been based. Each regional chapter has a bathymetric map, with more detailed maps of subregions or, in some cases countries, that show natural terrestrial features (forests, rivers, topography, etc), mangroves and reefs. The maps are based on the reef information available on the US Defence Mapping Agency Operational Navigational Chart Series, at a scale of 1:1,000,000. Data were then added from the 1988 IUCN/UNEP *Coral Reefs of the World* volumes, and additional material was gathered on an opportunistic basis, with particular focus on those countries where existing collated information was poor. This has allowed a new calculation of total area of reef – now estimated at 284,300 sq km (compared to 250,000 sq km in the 1997 estimate by Spalding and Grenfell). The problem of scale, as discussed in the atlas itself, means that there is little detail, but the information is being incorporated into Reefbase (www.reefbase.org), which means that it will be online and/or available on CD-ROM in the future, and thus available at a range of scales.

The text for each section will be useful to non-experts but perhaps frustrating for some scientists and conservation managers. Statements are not referenced (intentionally so, on account of the intended popular audience) and some of the information may seem superficial to those with an in-depth knowledge of any particular region. This, of course, is always a problem with global reviews of this kind, although perhaps a broader range of reviewers as well as a less selective list of sources (given in the 'selected bibliographies' at the end of each chapter) could have reduced this problem. Nevertheless, as a commercial publication, the atlas should appeal, and be a valuable addition, to the libraries of recreational divers, students, and teachers.

One warning is needed – for the scientist or expert it is essential to read the technical notes at the end of the atlas that explain how it was compiled. A brief summary of these notes at the front would have been very helpful. For example, for each country, there is a 'data table' with information on population, marine area, per capita fish consumption, reef area, recorded coral diseases, coral diversity etc. At first glance the figures could easily be misinterpreted. Thus, two figures are given for coral diversity – one from Veron's *Corals of the World* and a second from the UNEP-WCMC database of corals – and for some countries these differ significantly. Similarly

the records of coral diseases in each country need careful qualification; and it needs to be understood that the per capita fish consumption is taken from FAO fishery statistics and does not directly relate to reef-fish consumption. And don't get confused by the dive centers that feature on the maps, which are just those where certified training is provided; they are not a guide to the numerous and rapidly increasing number of dive shops where you can rent a tank and take to the water.

The atlas is not intended as a management tool, but the somewhat gloomy picture of conservation efforts on reefs is disappointing. Of course, the authors are entitled to their views, and Chapter 2 gives a good overview of the types of management interventions that are being used to protect and manage reefs. However, the descriptions of what is happening at regional and country level are often negative. The focus is on marine protected areas (MPAs), since UNEP-WCMC hosts the global database for protected areas, and lack of effective management is heavily emphasized. The many efforts underway with fishing communities, the tourism industry, coastal zone management agencies and other organizations to introduce sustainable management of reefs both inside and outside MPAs tends to be overlooked. Most people would agree that there is a long way to go before MPAs are effectively managed. Nevertheless, there has been an immense change over the last 20 years. When the IUCN/UNEP Directory of Coral Reefs of the World was published in 1988, fewer than 250 MPAs included coral reefs; the current total listed in the new atlas stands at 660, and this includes only those MPAs that are legally gazetted. Given the many community-based initiatives (there are over 400 in the Philippines alone), and the growing number of private sector 'reserves', there has clearly been a major change over the last two decades.

This attractive publication should be inspirational, and help people to understand the part that they and their reefs play in the global picture

However, in a welcome gesture, 150 free copies are to be made available to 'ground-based conservation initiatives relating to coral reefs in developing countries'. One of the first requirements of any reef management program is a map from which decisions about resource use and human activities can be made. The scale at which the atlas is designed means that it cannot be used in this way but it may encourage local efforts, which now involve not only scientists but also volunteer divers, fishermen and other reef users. This attractive publication should be inspirational, and help people to understand the part that they and their reefs play in the global picture.

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Soft Corals and Sea Fans A Comprehensive Guide to the Tropical Shallow Water Genera of the Central-west Pacific, the Indian Ocean and the Red Sea

Katharina Fabricius and Philip Alderslade (2001) 264 pages, 700 photographs, 90 panels of anatomical drawings. ISBN 0 642 322104. Published by the Australian Institute of Marine Science

This book's title promises guidance to those of us who have been lucky enough to wonder just what's what with these softies that adorn so many coral reefs and associated habitats. 'Equal value to professional scientists, students, divers, aquarium owners and nature enthusiasts' proclaims the cover note. How does it live up to this promise? Very, very, well. It grabs your attention, it holds it, and it delivers the goods. The sensual delights of this compact but substantial book are apparent from the moment you see its cover's vivid pastels on translucent black, you feel its satiny texture, and you fan through its 264 beautiful pages. The intellectual rewards are not far beneath the surface.

It grabs your attention, it holds it, and it delivers the goods

This is unquestionably a book for many types of professional scientists to take on field trips. For those wanting to make an identification, there is an outstanding 20 page introduction to the 23 families and 90 genera, lavishly illustrated with representative photographs (in as much as that is possible in such a diverse group). Then, for over 200 pages, ninety genera are represented, typically one per double opening. On the left is a standard formatted text and excellent line drawings of diagnostic features. On the right is a full page of four to eight panels of color photographs that illustrate both the variety within the genus and the detailed features that an intent diver would see through his or her face mask. The pictures are of such uniformly high quality, they will help the naturalist make a generic identification with a high degree of confidence – be it with only a mental picture from a just finished dive, or with a fresh specimen, or a close-up photograph. The propensity of the genus to occupy different habitats – silty or clear, shallow or deep, is recorded - a useful added clue to identification. Known zoogeographic distributions are also reported, but as the authors note, many are poorly known. If this book were needed for no more than an identification guide to the genera, the thoughtful selection and the excellence of the photographs, and the accompanying text would warrant its purchase. As the world's leading soft-coral specialist Dr Frederick Bayer states, it will 'remain a cornerstone for information about genera and families of the Indo-West Pacific Octocorallia for decades to come'.

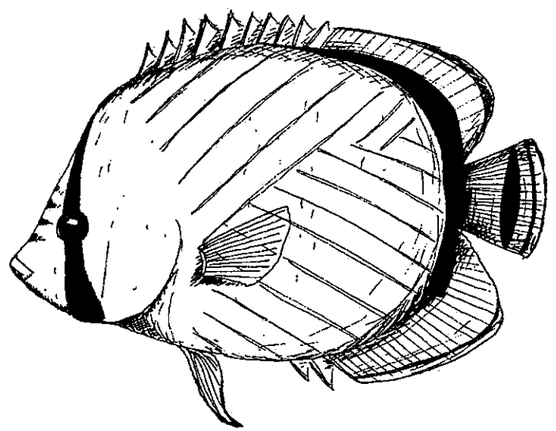
a cornerstone for information about genera and families of the Indo-West Pacific Octocorallia for decades to come

So too do most of the other forty or so pages have a lasting feeling about them. The authors succeed in creating relatively jargon free introductions to Coelenterate and soft coral classification, and their biology, enriched again by stunning photographs and excellent line drawings. Histology, anatomy, reproductive biology and nutrition are all briefly and engagingly covered. Techniques for anatomical and ecological study are discussed, as are issues for aquarists.

A selectively-referenced introduction to the relationship of octocorals physical environment covers storms, waves, current, light, nutrients, sedimentation, salinity and finishes with temperature, including valuable insights on soft-coral bleaching. The references and examples in this section are dominated by works by Fabricius and collaborators on the Great Barrier Reef and thus carry the authority of hundreds of hours of first-hand observation. They also include references to some of the most innovative work done in any form of spatial ecology in recent years which quantitative ecologists would do well to follow up. However despite the predominance of Great Barrier Reef examples, there are sufficient examples from other authors and places to reassure the reader of the generality of the broad environment-octocoral relationships described.

I found very few typographical errors or mistakes in referencing to Figures or Tables. The text occasionally slips into the vernacular. The statement 'some irresponsible bioprospectors have nearly wiped out local populations of desired invertebrates' is one example where it did. It was also where one might have expected reference to the efforts to isolate and synthesize active compounds as the way of the future, rather than the more destructive harvesting and extracting. I felt the 'surveying octocoral communities' section could have been used to more strongly promote the value of size and abundance versus percent cover as the way to go, but that's probably just my personal bias coming through. These minor quibbles do not detract from the book's many outstanding qualities. This is a book that will reward all with an interest in coral reefs, and I heartily recommend it to you.

Terry Done



BOOKSHELF

Field Guide to Coastal Fishes of Mauritius
H Terashima, JI Mosaheb, CN Paupiah and V Chineah (2001) Albion Fisheries Research Centre, Ministry of Fisheries, Mauritius ISBN 99903-22-11-2

A field guide to coastal fishes of Mauritius has just been published by the Albion Fisheries Research Centre (AFRC) of the Ministry of Fisheries of Mauritius and the Japanese International Cooperation Agency (JICA). It's the result of two years of research into fish biodiversity in Mauritius by scientists of AFRC under the guidance of Dr. H.Terashima from JICA.

The field guide mainly describes the fishes from fringing coral reefs. Most were photographed in their natural habitat (at twenty sites around the island from the surface to 30 meters). A few specimens were sampled in deeper waters (up to 62 meters) and some were found in the local market and photographed in the laboratory.

Much of the published information in the guide is developed from a fish database set up at AFRC in 1998. This database is still being upgraded as additional specimens, some not yet described, are sampled during routine field surveys. At least three hundred and forty fish species have been recorded.

The most common species around the island belong to the families Labridae, Serranidae, Pomacentridae and Chaetodontidae, although another 59 families were found, and many rare and endemic species are described in the manual.

The manual orders fish according to their evolutionary status. Scientific, common and vernacular names (local but also Japanese) are included for each fish species along with information on maximum attainable size, feeding habit, morphological characteristics, geographic distribution, preferred habitat and known behavior. For many species there are is local information, such as whether the species is commercially fished or is considered toxic in Mauritius.

The beautiful photographs accompanying the descriptions should make this manual very appealing and easy to use for everyone from local fishermen to fisheries scientists. The manual is concise but very informative and will hopefully be valuable for field identification of coastal fishes of Mauritius and of the South West Indian Ocean.

The price of the book is Mauritian rupees Rs.200 (present exchange rate: US$=Rs28). There will be a reduction for an order of more than 10 copies at Rs175 per book. Shipping charges are additional and please contact the address below for details:

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WHO'S WHO

Reef Conservation UK (RCUK)

In 1996 individuals and organizations involved with, and having interests in, coral reefs came together to discuss International Year of the Reef (IYOR). Not only was this an opportunity to formulate the United Kingdom IYOR strategy, but it also opened new lines of communication and collaboration between individuals and groups in the UK who had never been in contact before, yet had similar interests and were involved in similar activities. It seemed both beneficial and appropriate to maintain these established links and to generate more. The advantages of increased communication between coral reef people in the UK were obvious, maximizing efforts for coral reef conservation and awareness, while minimizing the time and money which is required - commodities which many are short of these days. For this reason Reef Conservation UK (RCUK) evolved out of the original IYOR-UK committee.

Before RCUK there were few networking opportunities for coral reef researchers working in UK. This limited the scope for establishing collaborative research projects, disseminating results and building links between academics, students, consultants, NGOs and aquaria. This was aided by the establishment of a RCUK list-server, but more importantly the RCUK committee has organized one-day meetings every year since 1998. These conferences have been extremely successful, with over 100 delegates at a time.

A core component of the RCUK meeting has been a series of presentations from a range of subject areas including academic and student research, reef expeditions, conservation initiatives and tropical aquaria. Talks are selected to provide a general overview of the status of coral reef research in the UK and expose the entire community to a variety of topics. The informal setting of the meeting facilitates discussions and information exchange throughout the day.

> opened new lines of communication and collaboration between individuals and groups in the UK working on coral reefs

RCUK Newsletter

There have been occasional newsletters since RCUK began, but is now produced on an annual basis in order to further boost the lines of communication within the UK.

This has been an ideal way of letting other UK reef workers know what reef related work/interests individuals and organizations/departments are currently pursuing or are planning. The newsletter has included short articles, news items and announcements and details of current research, survey work, expeditions, educational initiatives etc.

Grant scheme

Although RCUK receives no core funding, the annual conference and charitable donations have provided sufficient funds for a small grant scheme (maximum £300). Funds are only for UK-based applicants/researchers/organizations who are conducting research or projects related to the study of coral reefs and adjacent environments and can encompass disciplines such as conservation, education, public awareness, ecology, resource management, and mapping. RCUK grant recipients are requested to give an oral presentation or a poster at the annual meeting.

To date RCUK has provided funding for the following projects:

- Conversion of a diving etiquette video to allow it to be shown by airlines en route to the Red Sea.
- Acoustic sea floor mapping in the San Andres Archipelago, Colombia.
- Surveying the effects of sedimentation on reefs in Fiji.

RCUK has also provided two grants for environmental education in Honduras. Initial funding provided snorkeling and interpretative materials, and the second extended this work by facilitating the production of a series of 'Reef Briefs' for distribution in local Honduran communities.

RCUK aims to expand its activities in the future with plans to promote its role as a focus for UK media agencies who are increasingly covering issues relating to reef conservation and who require accurate summary information and specialist contacts. RCUK also hopes to provide advice and guidance to UK based NGOs and governmental institutions on key conservation topics and recent advances in scientific coral reef research.

If you are interested in being kept informed about the activities of RCUK please contact rcuk@hotmail.com or have a look at the RCUK website: www.rcuk.org.uk

Kristian Teleki, Cambridge Coastal Research Unit; Alistair Harborne, Coral Cay Conservation, The Tower, 13th Floor, 125 High Street Colliers Wood London SW19 2JG UK Email <arh@coralcay.org>; Heather Hall, London Zoo, Regent's Park, London NW1 4RY UK Email <heather.hall@zsl.org>; Liz Wood Marine Conservation Society, 9 Gloucester Road, Ross-on-Wye, Hertfordshire, HR9 5BU UK Email <ewood@globalnet.co.uk>

MEETING REPORTS

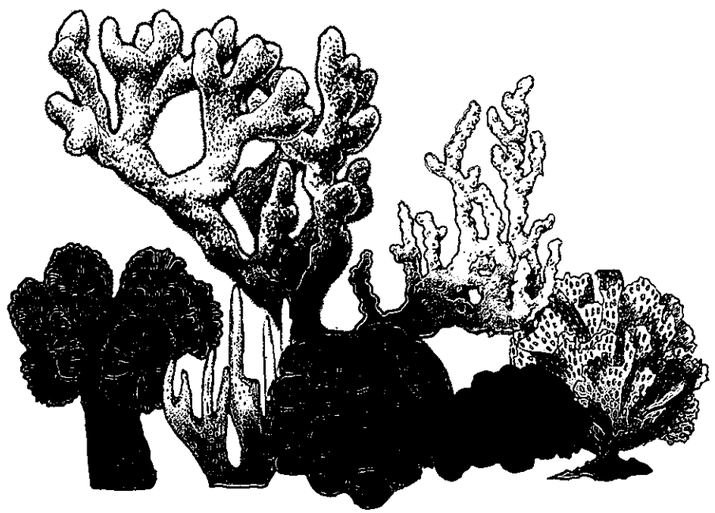
Resilient Reefs

Designing protected areas to reduce the impact of coral bleaching

Not all corals succumb to bleaching! Some show resistance (i.e. coral colonies don't bleach or partially bleach but don't die) or resilience (colonies bleach but recover to reestablish reef communities). Recognizing these patterns of resistance and resilience in our management strategies for Marine Protected Areas (MPAs) is a new concept that could reduce the impacts of bleaching on coral reefs worldwide. This is sensible, but also essential, if these areas are to survive the increased frequency and intensity of bleaching events predicted by many experts.

> A new concept that could reduce the impacts of bleaching worldwide

These were the conclusions emerging from a recent meeting of 12 international leaders in coral reef science and management. Coral bleaching, like that witnessed over large areas of the Caribbean, Indian and Pacific Oceans during the 1997-98 El Niño Southern Oscillation (ENSO), has the potential to kill on a larger scale than any of the localized, destructive activities on reefs linked more directly to people. Now The Nature Conservancy (TNC), who together with World Wide Fund for Nature (WWF) hosted the meeting at the Bishop Museum in Honolulu Hawaii, think that certain ecological factors favor survival or recovery of corals and other organisms affected by bleaching. The meeting outlined a general approach for a global program to test and verify this possibility, and worked out a list of likely factors. The group confirmed that policy makers and resource managers should be including resilient reefs within MPA networks. The emphasis is on the need to help bleached reefs recover by protecting them from other anthropogenic impacts that are far easier to tackle through MPA planning and management than seemingly unmanageable threats like global coral bleaching linked to climate change.



MITIGATING CORAL BLEACHING IMPACT THROUGH MPA DESIGN
MAY 29-31, 2001 • HONOLULU, HAWAII

The group plans to work with managers around the world to evaluate how vulnerable existing MPAs are, and to check the practicality of the new management approaches. To be useful, the environmental factors must be reliable and not respond to changes in atmospheric and oceanographic circulation caused by ENSO events. They include physical features that reduce temperature stress, flush harmful bleaching products, or decrease light stress - and so promote bleaching tolerance. Connectivity within and among reefs, strong recruitment, and several other ecological factors should also correlate with recovery where reefs are effectively managed.

> It could change the way we tackle coral reef conservation globally

The plan is to test how reliable these factors are through worldwide assessments, research and monitoring. The research is necessary to provide solid scientific evidence backing up the observations and limited empirical data we have at the moment. At the same time, new MPA selection criteria and design principles will be prepared and distributed so managers can apply, verify and refine the guidelines. The IUCN World Commission on Protected Areas (WCPA) will play a key role in this process. The aim is to assimilate both the results of research and feedback from managers in time to discuss the way forward at the IUCN WCPA 5th World Parks Congress in 2003.

MPA design has scarcely changed over two decades, and the current guidelines are still useful for coral reef conservation. But their limitation is that they are less useful for tackling the emerging global threats. For these we need new *mitigation* strategies that complement our usual range of *management* actions by planning for reef survival. This concept of coral reef survivability has never before been explicitly defined and listed as a criterion for MPA selection or design. It's a concept that needs to be carefully weighed and tested. It could change the way we tackle coral reef conservation globally, and might substantially reduce the expected impact of climate related bleaching on coral reefs.

If you, your project or programme want to get involved, contact Rod Salm (TNC) rsalm@tnc.org or Gilly Llewellyn (WWF) ghislaine.llewellyn@wwfus.org;

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Fishy Business in Durban

The 6th Indo-Pacific Fish Conference in Durban (20-25th May 2001) presented a star line up. Dr Ben Ngubane, South African national minister of Arts, Culture, Science and Technology opened the meeting. And before the first plenary a special guest was introduced - none other than the sprightly 94 year-old Marjorie Courtenay-Latimer, who saved the first coelacanth for science way back in 1938. Jack Randall from Hawaii, the doyen of Indo-Pacific fish scientists, began the plenary talks, presenting a pictorial overview of reef fishes in the Western Indian Ocean and highlighting the diversity and endemism of fishes in the region. Lynnath Beckley gave a synopsis of marine ichthyology in South Africa, discussing the oceanography of the sub-continent, the accumulation of knowledge about South African fishes and the biogeography of coastal fishes. Dr Kent Carpenter completed the plenary session by describing recent advances in the study of phylogenetic patterns in sparid fishes based on both morphological and molecular evidence. This work is particularly relevant to South Africa as it has the highest diversity of sparid fishes in the world and the results challenge the traditional delineation of sub-families by dentition patterns.

The IUCN specialist group on sharks and the Society for the Conservation of Reef Fish Aggregations met during evening sessions. Kendall Clements chaired a timely discussion on the much debated use

Dr Marjorie Courtenay-Latimer, saying a few words to the assembled delegates. Left to right: Dr Courtenay-Latimer, Dr Paul Skelton (Director JLB Smith Institute), Dr Lynnath Beckley (Chairperson: 6th IPFC) and Dr Jack Randall (invited plenary speaker). Photo: Rudy van der Elst

of molecular and morphological characteristics for reef fish systematics.

Many of the contributed papers for sessions on coastal and reef fishes, systematics, marine protected areas, deep-sea fishes, pelagic fishes, estuarine fishes, fish larvae, reproductive mechanisms in fishes and chondrichthyans will be published as a special issue of *Marine & Freshwater Research* in early 2002. The conference was hosted by the Oceanographic Research Institute, in collaboration with scientists from the Natal Sharks Board, JLB Smith Institute of Ichthyology and the South African Museum.

Lynnath Beckley

DIARY

Second International Conference on Marine Ornamentals

Collection, Culture and Conservation
November 26 - December 1, 2001 Wyndham Palace Resort and Spa in Walt Disney World® Resort Lake Buena Vista, Florida, USA

The conference will focus on helping to create an economically and environmentally viable future for the dynamic marine ornamentals industry and its diverse clientele through:

- Improvements in the methods for the collection and distribution of wild marine ornamental species.
- Increases in the variety, quantity and availability of cultured marine ornamental species.
- Outreach activities in the conservation and husbandry of marine ornamental species.

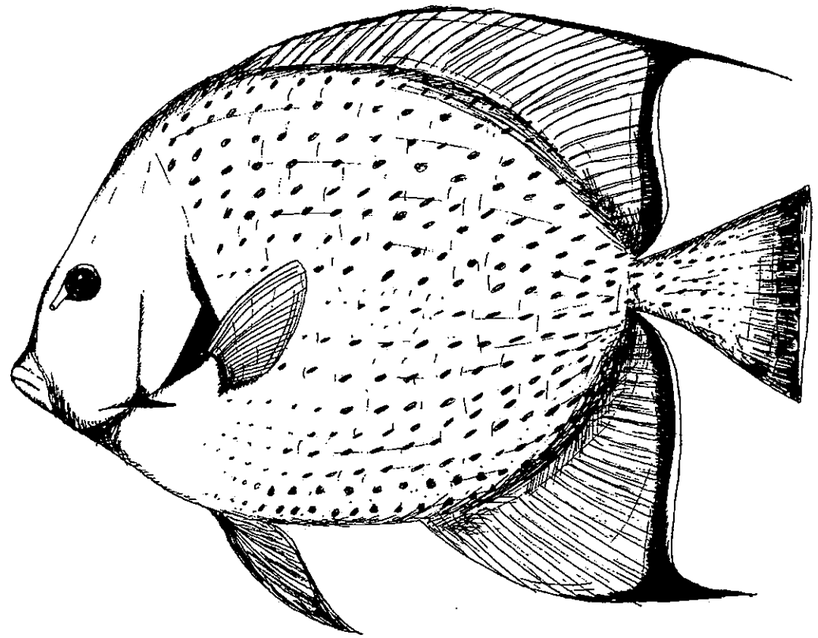
For more information, visit the conference web site or contact: Ms. Beth Miller-Tipton, CMP, Director, Office of Conferences and Institutes (OCI), Marine Ornamentals '01 - Conference Coordinator, University of Florida Leadership and Education Foundation, Inc. (UFLEF), Institute of Food and Agricultural Sciences (IFAS), PO Box 110750 Building 639, Mowry Road, Gainesville, FL 32611-0750 Tel: +1-352-392-5930 Fax: +1-352-392-9734 Email <bmiller-tipton@mail.ifas.ufl.edu>, Website www.ifas.ufl.edu/~conferweb/MO

Regional Experts to Meet in Maputo

If you're involved in reef-related research and management in the Western Indian Ocean you're invited to the next International Coral Reef Initiative (ICRI) Regional Workshop, to be held in Maputo, Mozambique from the 26th to the 28th of November. The workshop will discuss work already done, plan future activities and prepare a series of recommendations for consideration by the ICRI Coordination and Planning Committee (CPC) Meeting, which will follow the workshop (29th and 30th). The Annual Meeting of the CORDIO Program, which will focus on 'Research for Management of Coral Reefs of the Indian Ocean', will be held in conjunction with the workshop and CPC. Country Status Reports and Action Plans presented at the meeting will be fed into the Second International Tropical Marine Ecosystems Management Symposium (ITMEMS 2) scheduled for the Philippines next year, and the ICRI Report to the RIO+10 Conference.

In addition, the Third Conference of the Parties to the Nairobi Convention will be held the following week (December 5th – 7th), so the Workshop is an excellent opportunity to prepare recommendations for this important Meeting.

The Workshop is organized by UNEP-EAF/RCU and the CORDIO East Africa Coordination Office. You can find more details on the websites for ICRI (www.icriforum.org) and CORDIO (www.cordio.org). Alternatively, contact Rolph Antoine Payet (UNEP-EAF/RCU, Email: rolphap@seychelles.net, Tel: +(248) 224644/225672) or David Obura (Cordio, Email: dobura@africaonline.co.ke or dobura@hotmail.com Tel: (254) 11 486473).



continued from page 33

Seeking Sustainable Solutions: Fishing And Coral Reefs

A Statement From The International Society For Reef Studies

of bleaching are predicted to increase under the influence of global climate change.

5. Because of these other anthropogenic pressures, it is more important than ever that reefs should be fished sustainably if they are to continue to support food security of local populations, and to offer other sustainable opportunities for local income generation.

Management problems specific to coral reef fisheries

6. Several key factors make coral reef fisheries difficult to manage:
   a) The greatest pressures on reef fisheries can in some cases be generated by demand from international markets for reef products that are insensitive to the capacity of the coral reef ecosystem to meet those demands, let alone local needs. Products include frozen products, live fish for restaurants, and live corals and reef rock for aquaria.
   b) Coral reef fisheries that recruit through long-distance larval dispersal can effectively be transboundary stocks, a viable fishery in one country, requiring well managed parental stocks in another.
   c) Coral reef fisheries take an enormous diversity of creatures compared to fisheries in temperate seas, which may target only a few species. The data required for conventional management techniques that depend on an understanding of each species' biology and life history characteristics are prohibitively expensive for most countries with coral reef fisheries.
   d) Catches are often brought ashore at numerous and disparate landing sites, making enforcement of quotas or even monitoring catches problematic.
   e) Coral reef fisheries are often the last resort of the landless poor. Where no alternative incomes are available there may be no economic 'brake' on exploitation even where intense fishing drives catches, and hence earnings, very low.
   f) Coral reef fish have a bi-partite life cycle which is still poorly understood. Although adults are relatively sedentary, fertilized eggs and developing larvae disperse away from the natal reef. How far they travel before they return inshore is a topic of considerable debate between proponents of 'widespread dispersal' and 'local retention'. If larvae are widely dispersed, managing an adult population of reef fish may not guarantee a healthy stock if that managed population depends on an upstream source of larvae for replenishment. This is particularly relevant to Small Island Developing States where larval dispersion may act across international borders separating healthy and overexploited reef systems. Conversely, if larvae are locally retained (and there is mounting evidence that at least a proportion of larvae may return to near their natal reef) local actions have local consequences. Where local retention is significant, poor ecosystem and fisheries management may cause declining stocks; but good management will lead to local recovery of fished populations.
   g) Because of the patchy nature of coral reefs, recruitment overfishing of the replenishing population (whether local or upstream) can lead to local extirpation of an exploited species. If this happens, recovery may take decades rather than years, and may not happen at all without interventions such as stock enhancement.

Towards international solutions

7. International solutions are required for two problems:
   a) Unsustainable pressures on local stocks generated by international market forces, and;
   b) The undermining of one country's coral reef fisheries through overexploitation and/or habitat destruction of parental stock in another.

We believe there is an urgent need for interventions that are based on a) knowledge, understanding and regulation of the chain of supply from local fisher to international market place; and b) consideration of coral reef fisheries, where appropriate, as transboundary stocks that require management through bilateral and international agreements targeted at protection of reef habitats, spawning aggregation areas and parental stocks.

Towards locally effective solutions

8. Despite the difficulties described above, coral reef fisheries research can draw some general conclusions:
   a) Effective habitat management (for example through rigorously enforced No-Take Zones and amelioration of pollution) is a critical tool for management of the fisheries of coral reefs and associated habitats. Habitat management refers not only to coral reef areas, for at certain crucial periods in their lives, reef fish may need habitats away from their normal adult environment. For example, many commercially important groupers and snappers aggregate to spawn, and protecting these aggregations should be a priority. Also, it may be important to protect inshore nursery habitats such as seagrasses and mangroves where some juvenile fishes live before they move to their adult reef environment. Protection of such habitats may require that measures be taken onshore to reduce pressures from coastal development or pollution.
   b) On their own, No-Take Zones will not be sufficient to halt reef declines. Reductions in effort and elimination of destructive fishing are also needed.
   c) The scientific consensus is that a balance of widespread dispersal and local retention affects larval replenishment of reefs. Irrespective of the exact balance, coral reef fisheries need a network of interacting management initiatives at a variety of spatial scales in order to remain sustainable.

Call for action

9. The **International Society for Reef Studies** calls on the International Coral Reef Initiative (ICRI) to draw attention to the serious problems posed by unsustainable fishery practices and failures in integrated coastal zone planning. The Society further calls for immediate and effective action to ensure the sustainability of coral reef fisheries.

   We believe that solutions will need to be implemented through complementary international policies, regional agreements, and local management prescriptions. We note that the 'Code of Conduct for Responsible Fisheries' of the FAO Fisheries Department provides an excellent conceptual and institutional foundation for promoting the special needs of coral reef fisheries and ecosystems.

10. We believe that such actions will require both international and local interventions, and a 'whole coral reef ecosystem and society' approach to management. Attention should be paid to the nature of the fishery, the stocks themselves, their encompassing ecosystems, and the pressures exerted by both local needs and foreign markets. Effective management institutions and expertise must be supported where they exist, and established where capacity is lacking.

11. We believe important ingredients of international policy development, regional agreements and local management should include local, regional and international appraisals of stocks and fishery practices, market forces, broader ecology, and socio-economic particulars that canvas:
    a) the relative pressures of local, regional and foreign demands on the reef fisheries;
    b) alternative uses of coral reefs for activities such as nature-based tourism;
    c) the development of non-reef options for food security;
    d) the efficacy of tools and practices supporting sustainable fishing within the local socio-economic, cultural and ecological context, such as:
       - expansion and enforcement of no-take areas of appropriate sizes and in appropriate locations;
       - regulation of total allowable catch;
       - aquaculture - that is neither polluting, nor dependent on coral reef production for its artificial food supply - to reduce fishing pressure on the reefs;
       - methods for reef restoration and biodiversity augmentation of reef species, including aquaculture of valuable specimens for the aquarium trade;
       - amelioration of other detrimental effects on coral reef habitats and fisheries (such as destruction of adjacent habitats, and the influx of pollutants including fresh water, silts, and fertilizers).

Notes

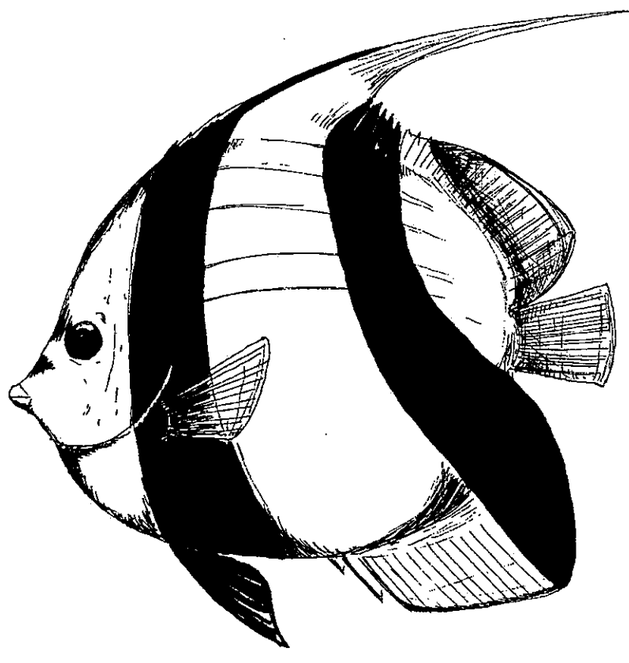
1 The **International Society for Reef Studies** is the premier professional society focusing on the science and management of coral reefs. The Society has a membership of over 1000 researchers and supporters from more than eighty countries. We are part of the International Coral Reef Initiative, tasked with ensuring that issues concerning the well-being of coral reefs and allied human populations are kept before the public, as well as appropriate government and inter-governmental agencies.

2 The **ISRS** Statements 'Coral bleaching – a global concern' and 'Diseases or coral reef organisms' are printed in **Reef Encounter** Nos. 24 and 25, and available therein on the **ISRS** web site at www.uncwil.edu/isrs.

Compleat Reef Encounter

"We were happy to see the sea floor on these shallow Caribbean Banks - shoals - consists largely of sandy bottom, with intermittent rock outcroppings and coral heads spaced widely apart. (All the better to avoid them during the pouring of pilings for foundations!)"

An excerpt from a trip report by Prince Lazarus to the Principality of New Utopia (www.new-utopia.com or www.nuresort.net)



Cover image: Cowfish (*Lactophrys* spp.) approximately 2 cm long (Photo: M. Watson).