EDITORIAL

This issue we welcome Maria João Rodrigues as a **Reef Encounter** editor. She will be our Contributing Editor from East Africa and the Western Indian Ocean. Maria João works for the Fisheries Research Institute in Maputo, Mozambique, but after she joined the team she was awarded a scholarship to study in Australia in 2000. No problem – in this day of electronic communications we hope she will be in a good position to find us articles on both sides of the globe. We are still looking for Contributing Editors from Latin America / Caribbean and especially Asia / Pacific. If you want to volunteer, or know someone who would be interested, please drop us a line.

Reef Encounter 26 was edited as hurricane Jose hurled through the Caribbean. As the storm loomed emails were frantically exchanged, back ups made, and essential files transferred to Kristian in the UK in case of disaster.

ISRS and the Center for Marine Conservation are sponsoring another student scholarship (**ISRS News**), which reminds us we forgot to define STAP – the student travel award program in the last issue.

We have quite a 'high tech' flavour this time, with **Features** on remote sensing and coral reefs, and **News** of systematics on the internet. We also bring armchair travelers a glimpse of the Eastern Pacific island of Clipperton (**Currents**) and French Indian Ocean Territories of Reunion, Mayotte and Les îles éparses (**Country Profile**). Very many thanks to all who contributed, especially Sue Daly and David Righton for illustrations.

Maggie, Kristian and Maria João

ISRS COMMENT

From the President

Having been lucky enough to have reaped the benefit from both the vision and efforts of previous office bearers of the Society, I was honoured by the chance to take my turn as president. In my first solo message last issue, I expressed cautious optimism for 9th International Coral Reef Symposium (9ICRS) scheduled for Bali. In the second half of 1999, progress towards that occasion has been difficult, but there is still steady forward momentum. At present (October 23rd, 1999), the Government of Indonesia is committed to continue with hosting this meeting, and is in negotiation with **ISRS** to bring back on track a process that was derailed by a combination of factors (see Report in **ISRS News**).

In the past, the Society has not played a major role in organization of the ICRS. Traditionally, we contributed members to the selection panel, and as individuals, we organized sessions or simply turned up, according to our personal inclination. At the 8th ICRS in Panama (June 1996), when Indonesia was selected as host for the 9th ICRS, the Society accepted an important role in organisation of the scientific program. Although this was a major and unexpected break from past practice, we took it on in the spirit of lending a hand to a country whose coral reef fraternity was capable and enthusiastic but few in number. Indeed, a good program of plenaries, contributed papers and mini-symposia is developing (see **Diary**), and a reliable Web page is established. In short, key elements are developing for a great meeting. Special thanks to Suharsono (our councilor on the Indonesian organizing Committee), David Hopley (Scientific Program Coordinator), Daphne Fautin (Treasurer), John Ogden (US fund raising), and Dick Dodge and Kevin Kohler (Web page—www.nova.edu/ocean/9icrs) for their efforts.

Occasionally, it's worth reminding ourselves of the common passion for coral reefs that binds members of this Society. There are about 750 of us from around 50 countries, every one of us is involved because we think coral reefs are pretty special. At a more prosaic level, we are 'not for profit', and our

income and expenditures each year tend to be closely matched. Your annual subscriptions are used to produce our two publications and we also solicit donations to allow us to award student prizes and support a subsidy scheme for a small number of prospective members who can make a strong case based on special need and service. By taking out a 'sustaining membership', you can assist these very worthwhile causes (see article in **ISRS News**). Membership also entitles you to attend our own international meetings, and ICRS at a subsidized rate.

As **ISRS** president, I now have a seat on the Coordinating and Planning Committee of the International Coral Reef Initiative (ICRI-CPC) (see **Reef Encounter 25**, p38). As a policy and management-oriented group, ICRI has been very appreciative of the clear, concise authoritative statements we produced for coral bleaching (**Reef Encounter 24**, 19-20) and coral diseases (**Reef Encounter 25**, 24-26). In their March meeting, ICRI-CPC expressed interest in a statement on 'how to implement sustainable fisheries on coral reefs', - a modest little undertaking! Other suggestions from our members have included 'effects of runoff' and 'the aquarium trade'. If you feel you would like to use the ICRI connection to influence reef conservation and/or raise awareness of particular issues, consider leadership of, or contribution to, a consensus statement to be reviewed and endorsed by a Council-led panel.

I wish you all the best for this very special change in Century.

Terry Done

ISRS NEWS

More for your Money!

You will have noticed that **Reef Encounter** grew in 1999 to a record number of pages. You will have noticed that your 1999 membership directory is the largest **ISRS** has produced. And those of you who receive **Coral Reefs** will have noticed it is larger than ever — about 400 pages in 1999 compared to about 260 pages just a couple of years ago. **ISRS** dues have been unchanged for several years. We have been able to bring you these increased pages without raising dues — so far.

In addition to more pages, **ISRS** has undertaken several initiatives – all at the urging of you, the members. These include:

1) The Student Travel Award Program (STAP) to enable a student to make a research presentation at a regional or international reef meeting;
2) Subsidized membership for some people who would like to belong to ISRS but cannot afford the dues (see a description of this program later in **ISRS News**);
3) Sponsorship of the International Coral Reef Symposium.

The additional pages and programs all cost money. In addition, although inflation is low, it exists. In order not to run into debt, the **ISRS** Council has voted to increase dues modestly for the year 2000. A student membership will cost US$25, an individual membership will cost US$80, a family membership will cost US$90, and a sustaining membership will cost US$200.

A major reason the dues increase is modest and so long after the previous one is our Sustaining Members. Each of them helps underwrite the operating expenses of **ISRS**, and we are extremely grateful to all of them for this important contribution to the Society. If you are able, please consider renewing at that level.

You should be receiving your renewal notice at about the same time you receive this issue of **Reef Encounter**. Please renew promptly — it saves **ISRS** money by reducing the number of mailings that have to be made to you. If you or someone you know wants to apply for subsidized membership, please follow the procedure on page six. And to everyone, I look forward to seeing your names in the **ISRS** membership directory for the year 2000.

*Daphne G. Fautin, **ISRS** Treasurer*

Status Report for the 9th International Coral Reef Symposium

For the latest update - see www.nova.edu/ocean/9icrs

At the time of going to press (November 1999), Bali remains the venue for the 9th International Coral Reef Symposium. This follows an 'on again - off again' September and October, during which the Symposium and **ISRS's** involvement in its organisation were derailed by a combination of factors:

- **ISRS** experienced intense lobbying to withdraw, reflecting individual reactions to the overall situation in Indonesia during 1999.
- Widespread concerns about timing, visas and safety were circulated very publicly via email, and were reflected in unwillingness of many potential participants to register.
- There were serious difficulties with critical communications between the Indonesian Organizing Committee and **ISRS**.
- **ISRS'** assessment was that this combination of factors was seriously putting at risk the scientific and financial viability of the meeting.
- **ISRS** has committed a great deal of time, its own funds, and the carryover funds from 8th ICRS (Panama) to 9th ICRS and recognized the serious implications of a breakdown.

ISRS President Terry Done convened an Extraordinary Council Meeting conducted by email from 17th to 25th September 1999. Council decided, by a majority vote, to relocate the Symposium to a time and place yet to be decided, and informed the Indonesian Organizing Committee of its decision on 26th September. This was then relayed to Indonesia's Minister of State for Environment, but he rejected **ISRS'** authority to make such a decision and put it back to **ISRS** for comment. **ISRS** Council agreed to review its position based on new information to be solicited from the Indonesian Organizing Committee.

Presently, there is a spirit of goodwill and a much improved communication between **ISRS** and Indonesian counterparts. The **ISRS** has made major progress on the development of the Scientific Program (see **Diary**). It is expected that the Indonesian Department of State for the Environment will confirm its commitment as host on a meeting scheduled for 19th November 1999.

International Society for Reef Studies and the Center for Marine Conservation Graduate Fellowship for Coral Reef Research 2000

Background and Fellowship Goals

Coral reefs are among the most diverse ecosystems on the planet, they are globally distributed, and they support various aspects of coastal economies. Yet coral reefs are widely recognized to be in decline and studies are needed to provide information to manage and understand processes that cause coral reef change. Funds are available, approximately US$10,000, to support one student to work toward a Ph.D. in the general area of coral reef ecosystem research. The focus of the Fellowship is to understand and predict coral reef response to management or disturbance-caused change (human-caused or natural). Research supported by

the Fellowship should emphasize an ecosystem approach. For example, projects that focus on factors that control productivity, nutrient dynamics, carbonate accretion or erosion, fisheries, or the effects of exploitation of coral reef resources are examples of suitable topics. Projects that address such issues within the context of marine reserves are especially suitable for Fellowship support. Projects are not limited to these topics, but research should increase understanding of reef function that is relevant to management at local, regional, or global scales.

Who can apply?

The Fellowship is available to students, worldwide, who are already admitted to a graduate program at an accredited university. The intent of the fellowship is to help Ph.D. students develop skills and to address problems related to relevant applications of coral reef ecosystem research and management. The Fellowship can be used to support salary, travel, fieldwork, or laboratory analyses. The student can work entirely at the host university, or can split time between developed and developing country universities.

Application materials

A three page proposal, using 12 Font or larger, double spaced, in English, is required from prospective fellowship candidates: proposals that do not meet these criteria may be returned. The proposal should include:

(1) a short overview that places the proposed research in context with existing literature and local needs,

(2) a methods section that includes hypotheses and experimental design (as appropriate),

(3) expected results,

(4) evidence of host country management relevance and coordination (e.g. identification of individuals or programs that will benefit from your results),

(5) a detailed budget,

(6) literature cited (the budget and literature cited sections do not count against the three page limit).

An electronic version (any standard word processing format is acceptable) and three written copies of the proposal should be provided. Electronic submission via email is acceptable but written copies must also be received by the deadline (see below). The student's major professor is required to submit a CV (maximum length 3 pages) and a support letter, in English, that details cost sharing and facility support. If work will be conducted at a second university, a support letter is required from the sponsoring professor. Applications will be reviewed by a panel with **ISRS** and Center for Marine Conservation participants. Evaluation criteria include scientific merit, feasibility, cost sharing, host country coordination, and relevancy to the Fellowship guidelines.

SUBMISSION DEADLINE IS January 31, 2000 (Award to be made by March 31, 2000)

Administration of the Fellowship

The International Society for Reef Studies (**ISRS**) and the Center for Marine Conservation (CMC) support the Fellowship through professional and administrative contributions. The mission of the **ISRS** 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. The CMC is committed to protecting ocean environments and conserving the global abundance and diversity of marine life. Through science-based advocacy, research, and public education, CMC promotes informed citizen participation to reverse the degradation of our oceans.

*Application materials should be submitted to Steven Miller, **ISRS** Recording Secretary, UNCW, 515 Caribbean Drive, Key Largo, Florida 33037, USA. Email: <smiller@gate.net> Please visit the **ISRS** Homepage http://www.uncwil.edu/isrs for additional information related to the Society and the Fellowship.*

Subsidised Subscriptions to ISRS

Financial assistance for prospective members of **ISRS** was advertised in the last **Reef Encounter**, and the following procedure will be adopted with respect to applications received in 2000. Applicants should write a letter (maximum 800 words, no supporting documents are required) identifying their parent institution, the nature of their work, the type of membership requested and their case for re-

questing financial assistance with membership fees. This letter should be addressed to the President of the Society, Dr.Terry Done and sent to Richard Aronson **ISRS** Corresponding Secretary, Dauphin Island Sea Lab, 101 Bienville Boulevard, Dauphin island AL 36528, USA; Email: <raronson@jaguar1.usouthal.edu> by 1 March 2000. Successful applicants will be required to make some contribution to their subscription since assistance given by **ISRS** will be no more than half an individual, student or family membership. Normally up to three new awards would be made in any calendar year though the actual number of awards allocated will rest finally with the discretion of the sub-committee of Council appointed to evaluate applications. Awards would normally be held for a one year period with further extensions being considered by the sub-committee. The sub-committee would consist of the President, Vice President, Treasurer and Corresponding Secretary of **ISRS**. Successful applicants would be notified by 30 April each year.

The success of this scheme will depend heavily on sponsorship from donations both from within and outside the Society and in particular from sustaining memberships. We would ask all who can, to consider renewing their membership in the sustaining membership category in the year 2000 since it is these subscriptions that enable us to extend our Society benefits worldwide, to provide travel support for young scientists to attend our meetings and to offer reduced membership rates to those with legitimate needs.

ISRS Elections in 2000

Elections for Treasurer, Recording Secretary and several other councillors will be held in late 2000. These posts are a chance to help guide the society and make a significant contribution to the impact of **ISRS**. Please think about standing for election if you would like to get involved. We hope to publish candidate statements in **Reef Encounter 27**, due out in July 2000. Both Daphne Fautin (current Treasurer) and Steven Miller (current Recording Secretary) have stood for two terms in office. The society could not function efficiently without their contributions and we are very grateful for all their hard work.

NEWS

Fish Kill in the South Eastern Caribbean

Reef fish in the south eastern Caribbean suffered a major 'kill' last September. Following reports of minor kills of siganids from Guyana in late August, approximately 30 benthic reef-associated species were affected in Tobago, St. Vincent and the Grenadines, Grenada, and Barbados. No external lesions were reported, but some fish showed discoloration of the liver and swelling of the heart. Preliminary investigations by a veterinary pathologist show *Streptococcus* bacteria were present, but both the cause of infection and the actual cause of death are still unknown. The kill coincided with the intrusion of a fresh water lens from the Orinoco river. This fresh water normally brings good fishing to Barbados, but in 1999 literally tonnes of fish washed up dead on beaches in the south east of the country. Both fishing and tourist industries have been affected. Demand for fish dropped 60% in St. Vincent, and fishing effort fell by 75%. The fish kill highlighted the need for both baseline data on bacterial infections, and a scientific protocol for dealing with such problems. Fisheries officers are still attempting to piece the evidence together. If you can contribute information, please contact Patrick McConney, Chief Fisheries Officer, Fisheries Division, Princess Alice Highway, Bridgetown, Barbados (Email <fishbarbados@caribsurf.com>) or Peter Murray at the OECS in St. Lucia (Email <pamollox@hotmail.com>).

Internet Systematics for Corals

A 'knowledge-base' is under construction for the coral family Pocilloporidae from the Mascarene Archipelago. The project is part of the IKBS (Iterative Knowledge Base Sytem for corals) — a new software designed to contain the 'know-how' of experts describing, classifying and identifying organisms in a given taxonomic group. The aim is to draw up a thesaurus of terms and illustrations in order to reduce misidentifications due to differences of interpretations. Scientists and collections of specimens are distributed around the world, but now experts can study systematics remotely via the internet. Each expert is responsible for a family (Pocilloporidae, Fungiidae, Poritidae, Agariciidae). Using video-conferences they share their interpretations of specimens under the microscope and build a knowledge base. IKBS can manage complex knowledge (structured, variable, imprecise, noisy) through a 'knowledge management cycle' which is divided into three phases of acquisition, processing and refinement.

Now experts can study systematics via the internet

During 'knowledge acquisition', the expert defines and describes a taxonomic domain with observable characters (objects, attributes, values). These are structured in a 'descriptive tree'. A meticulous choice of vocabulary, drawings and images is essential for a robust knowledge base. Next, a questionnaire matching the descriptive model is automatically built and used by scientists as a guide for collecting descriptions of specimens. The expert then puts the correct name to each description.

During processing, the system 'learns' the descriptive tree by discriminating between correctly named examples. Classification rules (diagnoses) can also be generated. Now users can identify new specimens by following tree 'nodes' from the 'root' to 'leaves' and answering questions. IKBS can even switch to alternative questions when an answer is missed, simply following another decision sub-tree.

Finally, 'knowledge refinement' uses an iterative process to evaluate the robustness of the descriptive model by experimenting with the pre-classified specimens. Resulting identifications and the way the test data fit the questionnaire allow the expert to detect problems such as errors in descriptions, misunderstood characters, or poor illustrations. Nine taxa (species and ecomorphs) of the genus *Pocillopora* have been used in a preliminary test. About two thirds of identifications made by non-specialists were correct, and that proportion is expected to increase as the software develops.

*David Grosser *, Noël Conruyt, Gérard Faure and Michel Pichon. * IREMIA (Institut de Recherche en Math et informatique, ILE DE LA REUNION – FRANCE. Tel: (02 62) 93 82 86 Fax: (02 62) 93 82 60 Web: http://www.univ-reunion.fr/~ikbs*

Mozambique Develops Reef Management Program

With a coastline of over 2,700 km, Mozambique's coral reefs represent an important resource for artisanal fisheries and coastal tourism, helping to support almost 6.6 million people (see **Reef Encounter 24** p24-27). Although the reefs of Mozambique are not well studied, awareness of coral reef issues, scientific research and training about coral reefs are all increasing markedly. Currently, attention is focused on establishing an effective management program, and there have been a number of initiatives during 1999.

Awareness of coral reef issues is increasing markedly

In March/April a survey was undertaken to assess the reef loss from bleaching during the 1997-1998 El Niño. Later in August, a course on taxonomy and survey methods for coral reefs, hosted by the Ministry for the Co-ordination for Environmental Affairs (MICOA), was held at Xai-Xai, 200 km north of Maputo. Twelve participants from national institutions including the Fisheries Research Institute, Eduardo Mondlane University

and MICOA attended. Immediately after the course, a program to establish a network of monitoring sites was initiated. The objectives are to assess coral reef status and trends along the coast and especially reef recovery after past coral bleaching events. These activities were supported by SIDA/Sarec (Swedish Development Agency) and DANIDA (Danish Development Agency) to whom Mozambican scientists are very grateful. Technical assistance has been provided by Michael Schleyer from ORI (Oceanographic Research Institute) and David Obura from CORDIO (Coral Reef Degradation in the Indian Ocean – see **Currents** for details of this program).

Our coral reefs need assessment, and although we are still building our national capacity, it seems that we are definitely moving towards a better management of this important ecosystem.

Maria João Rodrigues, Fisheries Research Institute, P.O. Box 4603, Maputo, Email <rodrig@mail.tropical.co.mz> and Helena Motta, Ministry for Co-ordination of Environmental Affairs, P.O. Box 2020, Maputo, Mozambique.

Short Sharp Shock—The Economics of Blast Fishing in Indonesia

Blast fishing was introduced after World War II in the Indonesian Archipelago as an easy way to catch schooling reef fish, and it is almost considered a traditional fishing method. Although the damage to reef habitats has drawn a lot of attention, management and enforcement strategies capable of eradicating this illegal practice have not been found.

We recently investigated the economic costs and benefits of blast fishing at the scale of individual households and of the Indonesian society as a whole (Pet-Soede *et al.* 1999). A copy of the paper can be obtained from Lida Pet-Soede at Email <lidapet@ibm.net>.

We considered three scales of operation. 'Small scale' represents an owner-operated dug out canoe making approximately 20 one day trips a month and catching around 8kg per trip. 'Medium scale' means a boat around 5-6m long with four fishers, making approximately 15 trips a month but catching 75 kg per trip. Finally 'large scale' is a cabin boat (about 8m long) housing 16 crew and the owner. These boats stay out for eight days at a time and catch 1500 kg per trip. At the individual household level, the calculated benefits from three scales of operation show clear incentives for scale enlargement. Both crew members as well as boat owners have the highest net income per month in the large scale blast fishing operations at 197 US$ and 1100 US$ respectively. The cost-benefit balance at the society level shows a net loss due to blast fishing of 533,700 US$ per km^2 of coral reef when there is a high tourism potential and 30,400

US$ 3 billion is only a conservative estimate of total net loss

US$ per km^2 coral reef when there is a low potential for tourism.

This illegal type of fishing provides income and fish to a vast number of coastal fishermen who claim that they have no alternative to make a living. Our calculations show that the economic costs to society per km^2 of coral reef are nearly 8 times higher than the total net private benefits from blast fishing. Main costs are through loss of the coastal protection function, forgone possible benefits of tourism, and forgone benefits of non-destructive fisheries. Tomascik *et al*. (1997) estimated the total area of coral reefs in Indonesia at some 86000 km^2 in their book on ecology of the Indonesian Seas. US$ 3 billion is only a conservative estimate of the total net loss over 20 years if blast fishing is not prevented in Indonesia (86000* 33900 US$ for reefs with low potential value for tourism and coastal protection).

Descriptions of the key-features of blast fishing together with a quantification of the loss of functions of a reef area for coastal protection, marine tourism and fisheries serves two purposes. First, it is a major step towards raising political will for truly banning blast fishing from Indonesian waters. Second, it allows an evaluation of possible solutions aiming specifically at the social-economic problems that caused many coastal fishermen to start using explosives.

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Tomascik T, Mah AJ, Nontji A, Moosa MK (1997) The ecology of Indonesian seas. Part I & II. Periplus Editions (HK) Ltd.

Lida Pet-Soede, Fish Culture and Fisheries Group, Wageningen Institute of Animal Science (WIAS), Wageningen Agricultural University, PBX 338, 6700 AH Wageningen, The Netherlands; H.S.J. Cesar, World Bank, Environment Sector Unit for East Asia and the Pacific (EASEN), 1818 H Street NW, Washington, District of Columbia 20433, USA; and J.S. Pet, The Nature Conservancy, Indonesia Program, Jl. Hang Tuah Raya No. 42, Lantai II, Kebayoran Baru 12120, Jakarta Selatan, Indonesia.

Palawan–Last Resort for the Last Frontier

Palawan, the most westerly island of the Philippines, is locally known as the Last Frontier. Perhaps more accurately it should be called a last resort for natural resources in a country suffering heavily from environmental degradation, mismanagement and uncontrolled exploitation.

Palawan has 40% of the Philippines' coral reefs and one of the highest numbers of coral species in the world. Its reef fish are equally diverse with more than 900 species identified. A recently expedition by Conservation International placed Palawan in the top 15% of global marine biodiversity. The area also boasts the only marine World Heritage Site in the region, Tubattaha Reefs, one of the main tourist attractions of the country. Aesthetically Palawan offers some of the most beautiful and pristine marine and coastal environments in the region and this is reflected in the rapidly expanding tourism industry.

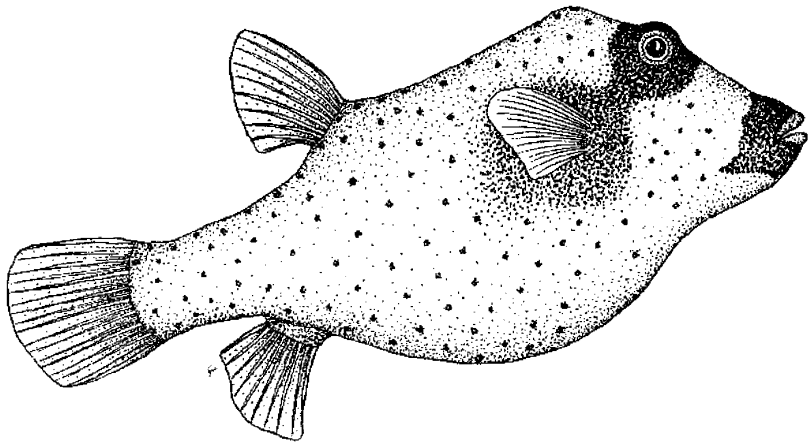
But high population growth, high immigration, extreme poverty, and escalating resource exploitation also characterize the Province. A staggering 4.5% annual increase in population, the largest in the region and twice the national average, is mainly concentrated at the coast. Unsustainable practices including cyanide and dynamite fishing are common in the sea, and are mirrored by problems of sedimentation and pollution from the land.

The Philippines has some of the best environmental protection laws in the world. But the irony is that such laws are rarely, if ever, enforced. However, Palwan has political 'clout' because it generates considerable revenue for the country as a whole, has informed citizens and a large and active NGO network. It is the only province with a holistic management framework; the Strategic Environmental Plan (SEP) legitimized through an act of congress. Palawan's challenge is to link conservation of its rich, but increasingly threatened resources to social and economic development.

The SEP supports integrated grass roots co-management through the Environmentally Critical Areas Network (ECAN). This bottom up approach tries to instil a sense of ownership and control, recognizing that the local people are the real day to day managers. Steering groups are made up of representatives from Local Government, local community leaders, NGOs, academe and Provincial Government agencies. In practice local government units are often suspicious of NGOs and of the provincial government agenda. It is also not uncommon for local government to be responsible for destructive (and illegal) resource extraction. Too much bureaucracy and too few resources slow progress. But ultimately the process relies on people power, and in Palawan, despite setbacks, and stumbling blocks, people are proving to be a force to be reckoned with.

Local people are the real day to day managers

Until moving to Tanzania, Sarrah Curran (Email: <Curran@altc.freeserve.co.uk>) worked with the Palawan Council for Sustainable Development Staff who implement and administer the SEP and ECAN. For further information, contact John F. Pontillas, PCSDS, Capitol Building, Rizal Avenue, Puerto Princesa City, Palawan, Philippines. Email: <pcsd@pal-onl.com>



Rapid Assessment of Coral Communities of Malpelo Island (Colombian Pacific)

Malpelo, a small (1.8 x 0.6 km) isolated rocky island, located 350 km from shore (3°51'07"N and 81°35'40"W), is one of the few Colombian sites in the Pacific which supports coral formations (Prahl and Erhardt, 1985). The shores and subtidal seafloors are predominantly rocky and very steep, and the water is clear. The island was recently declared an environmental protected area by the Colombian government because of its great biological diversity, an amazing abundance of large pelagic and bottom fishes and its biogeographic importance. Nobody inhabits this hostile and remote place except for some Colombian soldiers. Coral communities in Malpelo were described for the first time in 1972 when a scientific expedition from the Smithsonian Tropical Research Institute visited the island for six days (Birkeland *et al*. 1975; Graham, 1975). They estimated relative composition of hard bottom communities from photographic transects at 8 stations around the island up to 50m depth. No further studies of coral communities of Malpelo were carried out until 1999.

From June 1-5, the management unit of Colombian natural parks (UAESPNN) organized another short scientific expedition to the island with the support of the Colombian Navy vessel ARC Malpelo and several academic institutions. The "Instituto de Investigaciones Marinas y Costeras" (INVEMAR) contributed two researchers, funded by grants from COLCIENCIAS-BID (SIMAC project: 2105-09-327-97) and the Ministry of the Environment (Gorgona project: BID credit 774/OC/CO). They evaluated the status of coral communities and compared results with information obtained almost 30 years before. Despite limited time and a strong surge, the cover of major categories of sessile organisms and the health condition of coral species were assessed at eight stations between 10 and 30 m depth using rapid visual methods (following Díaz *et al*. 1995). The detailed results of this survey have been presented to the national agencies involved as a technical report and will be published soon in a local scientific journal.

"El Arrecife", the only developed coral formation in Malpelo, is found in front of a small inlet at the NE side of the island on a gradual slope. Birkeland *et al*. (1975) attributed the lack of coral elsewhere on Malpelo to vertical rock walls around the island, reduced light penetration and substrates unsuitable for reef construction. Hard substrata around Malpelo is covered principally by organisms such as crustose coralline algae, barnacles and sponges. Coral growth is restricted to small patches or isolated colonies. "El Arrecife" is a coastal fringing reef around 300 m long, with dense coral growth to about 30 m depth. It includes large stands of *Pocillopora eydouxi* and *P. capitata* in the shallow zone (9-12 m), enormous heads of *Porites lobata* and *Pavona* spp. at the intermediate zone (14-20 m) and numerous colonies of *Gardineroseris planulata* at the deep zone (26-30 m). This formation seems to have suffered a 20% reduction of the live coral cover since 1972 when a mean value of 65% was recorded (Birkeland *et al*., 1975). This decline, which may have originated in the 1982-83 bleaching event that affected many corals in the American Pacific (Glynn, 1990), is also seen in current levels of coral mortality (mean of 23% at "El Arrecife"). Nevertheless, live hard corals continue as the dominant bottom category (mean = 45%) in this formation, followed by the crustose calcareous algae (27%). As in 1972, *Porites lobata* is the most abundant hard coral species although *Pocillopora* spp. can dominate in the shallow zone.

Researchers compared results with information obtained almost 30 years ago

Among recognized signs of coral degradation, recent mortality was frequent but affected only small areas of the colonies and was related to disease or grazing by fish in most cases. Coral diseases were recorded for the first time in the Colombian Pacific during in this survey. The most frequent appears similar to White Band Disease (see Figure 1) and was

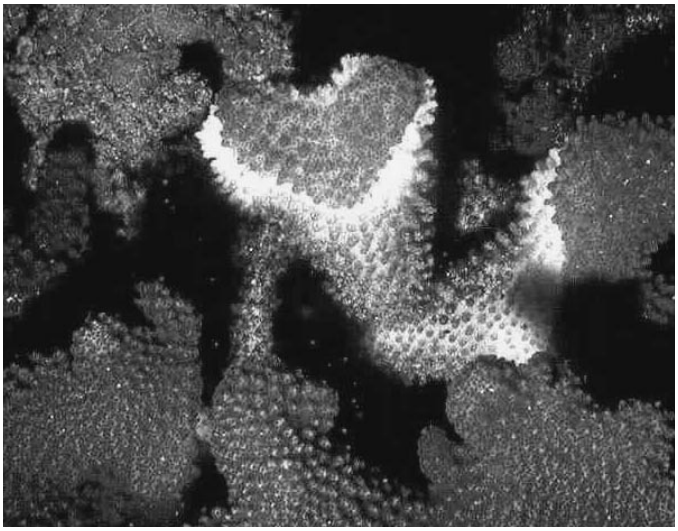


Figure 1. Close up view of a colony of Pocillopora eydouxi *with current mortality associated with the White Band Disease in Malpelo island.*

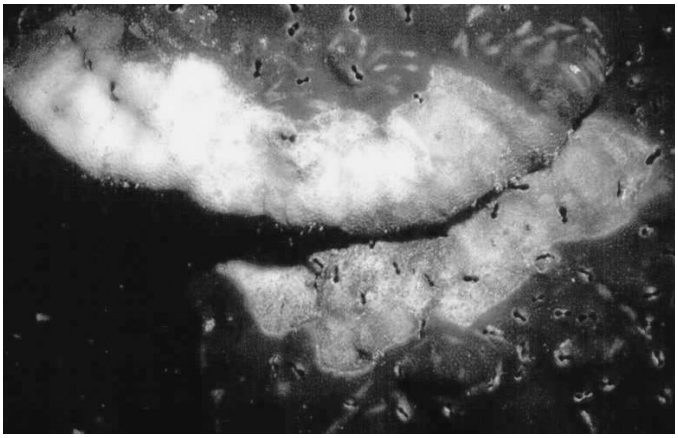


Figure 2. Close-up view of a colony of Porites lobata *in Malpelo island with current mortality associated with a syndrome similar to the White Plague Disease.*

seen attacking *Pocillopora* (50% in the records of *P. eydouxi* and 30% of *P. capitata*). This disease has also been recently recorded from the Indo-Pacific region in acroporid and pocilloporid corals (Santavy and Peters, 1997). The other coral disease observed in Malpelo is similar to the White Plague or Coral Plague, known from Caribbean and Indo-Pacific corals (Santavy and Peters, 1997). White Plague was seen only in a few colonies of *Porites lobata* in Malpelo (see Figure 2). Fish grazing on corals was also observed frequently, but only in two species, with 60% of the records from *P. lobata* and 50% from *Pavona clavus*. Grazing by fishes was prevalent on the same corals in 1972 (Birkeland *et al*., 1975) and was attributed to the activity of tetraodontids (*Arothron meleagris*) and balistids. Strong winds and swells occurred during this study, resulting in considerable physical damage to reef structure and coral colonies at "El Arrecife". This damage included extensive fragmentation of *Pocillopora* branches in the shallow zone, as well as overturning, fragmentation and abrasion of many massive colonies across the reef.

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Sand Mining: ICZM Perspectives in the Caribbean

Introduction

Sand mining is a major problem for many coastal states and small islands in the tropical, developing world. In the Caribbean region, from the Lesser Antilles to the Greater Antilles and to the island groups in the southwestern Caribbean Sea, sand mining is a major issue. At a regional workshop on beach management in 1996 (UNESCO, 1997; Cambers (ed.) 1997), seven of the sixteen attending country/territory representatives featured sand mining issues in their presentations. From the coast of Nigeria to the Atlantic Ocean islands of Saõ Tomé and Principe, the use of beach sand as a construction material creates problems. In many of the islands of the Indian and Pacific Oceans the need for construction material results in the mining of live and dead corals e.g. in Sri Lanka (Clark, 1996) and in Tarawa in Kiribati in the Pacific.

Generally lacking significant alluvial deposits of sediments, many tropical communities have been mining their beaches for these resources for decades, exacerbating the existing problems of beach erosion and shoreline protection and also degrading valuable or potentially valuable tourist beaches. Most inhabitants of the Caribbean islands can name at least one location where a beach(es) has been totally destroyed/seriously degraded as a result of sand mining – from Isabela in Puerto Rico to Old Town Bay in Providencia to Telescope in Grenada. When sand supplies on the beach run out, miners turn to ponds, rivers, lagoons and the offshore zone.

Environmental Impacts of Sand Mining

Whether extracting sand from the dunes, the beach or the offshore zone, it is important to recognise the integrity of the coastal system from its landward boundaries such as the watershed to the deep sea boundaries such as the edge of the shelf or 'drop-off.' For instance the beach does not end at the low water mark, instead the active beach/offshore area may be considered to extend offshore to a depth of 15 m (50 ft). Within this zone, sand exchange between the beach and offshore zone takes place. So dredging sand close to the beach will inevitably impact the beach itself. Furthermore, the impacts of dredging may be felt far beyond the 15 m water depth as currents can carry sediment plumes many kilometres. To take another example, at Sile Bay in Anguilla, a site where most of the 6 m high sand dunes were mined out in the 1980's, Hurricane Luis in 1995 reduced the *Acropora palmata* reef offshore to rubble and the sea encroached 46 m inland (Proctor and Hodge, 1996).

The major impacts of sand mining may be listed below:

- Beach and dune instability, erosion and possibly complete disappearance of dune and beach subsystems;
- Loss of dry land habitats for birds, crabs, nesting sea turtles etc. e.g. extensive sand extraction at Josiah's Bay in the British Virgin Islands led to chronic beach erosion of a beach that was once an important nesting site of the Leatherback Turtle, *Dermochelys coriacea;*
- Loss of offshore habitats such as seagrass beds and coral reefs (especially with offshore dredging);
- Higher than normal sedimentation of adjacent waters impacting habitats such as sea grass beds and coral reefs;
- Nuisance value for persons using the beach.

From the viewpoint of coral reefs, offshore dredging for construction sand or for beach nourishment purposes is likely to have a far greater impact in terms of habitat loss and increased sedimentation than the mining of the dry beach area. There will be two major areas of concern – near the dredge itself, and the runoff from the land area where the dredge effluent (a mixture of 70% water, 30% sand) is pumped and the sediment stored. In the early 1970's dredging for marl and sand in North and South Sounds, Grand Cayman, reduced water clarity significantly and impacted many types of

From the viewpoint of coral reefs, offshore dredging is likely to have a far greater impact in terms of habitat loss and increased sedimentation than the mining of the dry beach

coral. However, in this case, clarity improved after the dredging stopped and the corals recovered (Wells, 1988). In St. Lucia, sand mining associated with construction and dredging at Vigie Bay, caused serious beach erosion and damage to the offshore coral and algal communities (Dubois and Towle, 1985).

This is not to say that dredging has to be bad news for coral reefs, if planned properly with environmental impact assessments and detailed dredge plans and executed with full compliance monitoring, dredging operations can supply sand with minimal damage to the offshore habitats. Sad to say, this is rarely the case in the Caribbean region. For too many administrators, the offshore area is unseen, therefore damage or impacts are of little concern until brought to their attention by divers, fishermen and others, by which time the damage has been done and little can be done in the way of mitigation.

For too many administrators, the offshore area is unseen, therefore of little concern

Mining of beaches, by contrast probably only affects offshore biological habitats indirectly. Increased instability of the beach and the nearshore areas, may result in some increased sedimentation for coral reefs and seagrass beds, but is probably insignificant in comparison with sediment loads generated by heavy rainfall over land cleared for development or agriculture. In many islands even moderate rainfall results in heavily sedimented waters extending offshore more than 1 km.

Not so much a case of managing the biological/physical systems, rather a case of understanding human perceptions

Socio-economic Aspects of Sand Mining

More than two decades of practice of integrated coastal management (ICM) in the Caribbean has shown that it is not so much a case of managing the biological/physical systems, rather a case of understanding human perceptions, uses and needs regarding the particular system. There is no universal solution, instead as with many aspects of integrated coastal management from coral reef conservation to integrated rural development, approaches need to be tailored to local conditions and individual countries/islands' needs and conditions. The following case study illustrates a small success story from the Caribbean and is based on Gunne-Jones, A. and Christopher, W. (1997), and Gunne-Jones, A. (1998).

The government led by example and used quarry sand in all its projects.

The Case of Montserrat

Montserrat is a small (100 km^2) volcanic island in the Lesser Antilles in the Caribbean Sea. In 1990 it had a population of about 10,000. Agriculture and tourism were the main industries. Beach sand mining had been a traditional practice for decades. A construction boom, associated with tourism, starting in the 1960's, combined with a local change over to stone (cement) houses, led to a huge demand for sand and aggregate and resulted in serious beach erosion. Legislation to control sand mining, introduced in 1970, was inadequately implemented. Hurricane David in 1979 compounded the problem, the hurricane caused serious beach erosion, as did the country's efforts to rebuild its infrastructure – which necessitated taking more sand from the eroded beaches. Proposals to control the mining and utilise offshore sand sources were prepared but never implemented. Ten years later another hurricane (Hugo in 1989) resulted in a repeat of the erosion/infrastructure- rebuilding scenario. Finally, after two devastating hurricanes, measures were taken to control sand mining and try to conserve what was left of the beaches. Between 1990 and 1993, a strategy evolved which had several components, including the purchase of a new crusher to make sand at a quarry, involvement of contractors, builders, architects and engineers as well as extensive public awareness from magistrates to taxi drivers, restriction of mining to one beach and introduction of a permit system. The government led by example and used quarry sand in all its projects.

This combination of measures and political-will controled beach sand mining, and a monitoring program showed the beaches increased in volume over the period 1990-1994. Unfortunately, the story does not end there. In July 1995, the volcano on Montserrat erupted and there followed 3 years of serious volcanic activity, 60% of the population fled to other countries, the remaining 40% were relocated to the northern third of the island, the 'safe zone.' The capital city, the port, the airport and the quarry were all in the unsafe zone and inaccessible. Sand mining started again on the

few available beaches. In 1998 the volcanic activity subsided, although it has not completely stopped. Residents are returning slowly, although half of the island is still unsafe for human habitation. A rebuilding effort is underway. Aid funded projects use imported sand, but old habits die hard and people are turning once again to the beaches despite the existence of large, new, volcanic deposits of sand along some of the old river valleys and mountain slopes.

A permanent change in people's attitudes is not achieved in three years, possibly it takes generations.

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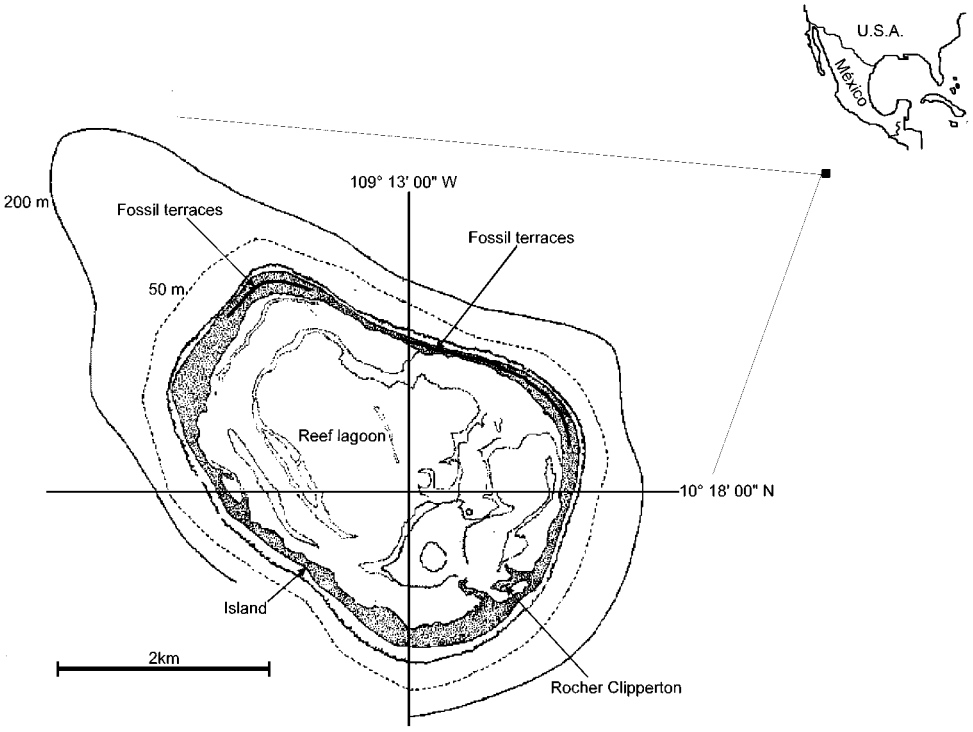
Clipperton, Île de la Passion

Clipperton is the eastern-most atoll in the Pacific Ocean, as well as the most remote territory on the Tropical Eastern Pacific Zoogeographic Province. The island itself, located at 10°18'N 109°13'W approximately 1,100 km off the Mexican mainland, is the emergent portion of an atoll only 3.7 km^2 (Glynn *et al*., 1996) possessing the main characteristic features of Pacific atolls. Clipperton was discovered in 1526 by Spanish vessels looking for a better route for traveling to Asia, and belonged to México until the King of Italy granted its political ascription to France in 1931. In the 19th Century, France and the United States exploited guano deposits, and from 1897 to 1917 Mexican marines and their families lived on the island. Since they abandoned Clipperton, there have been no permanent residents, but the island has been used as a military base (during the Second World War) and recently, as a refuge for fishing boats.

This century, Clipperton Island has been visited by American and French researchers, who have published observations and data on the natural history of the atoll (Hertlein and Emerson, 1957; Sachet, 1962a,b; Garth, 1965; Salvat and Ehrhardt, 1970; Emerson, 1994; Howell and Webb, 1995; Glynn *et al*., 1996; Robertson and Allen, 1996; Allen and Robertson, 1997). However, Clipperton's chequered



history (Table 1.) is rarely mentioned. In 1997, a Mexican scientific expedition visited Clipperton Atoll on board the R/V "El Puma", during the SURPACLIP-I cruise organized by Dr. Vivianne Solís-Weiss, researcher of the Instituto de Ciencias del Mar y Limnología of the Universidad Nacional Autónoma de México (UNAM). Researchers from several Mexican research institutions participated including UNAM, Universidad Autónoma de Baja California Sur (UABCS), El Colegio de la Frontera Sur (ECOSUR), Universidad Autónoma Metropolitana (UAM) and Centro Interdisciplinario de Ciencias Marinas (CICIMAR). The main goal of this expedition was to obtain data on the ecological and oceanographic conditions of the atoll. Corals, polychaetes, mollusks, crustaceans, echinoderms and fishes of Clipperton were studied. Water samples were collected from the lagoon, and some physical, chemical and geological factors of adjacent marine waters and bottoms were studied. The general morphology and characteristics of Clipperton's emerged portion were discussed in detail by Sachet (1962a, b), and although there are now some differences in vegetation cover, the general landscape is still quite similar.

On the island there are fossil terraces, composed of colonies of the genus *Porites* and *Pocillopora* forming a framework approximately 6 m above sea level. Considering reported sea levels in the eastern Pacific and other factors such as atoll subsidence, it is possible that the these terraces may be at least 5,000 years old (Carricart-Ganivet and Reyes-Bonilla, 1999).

The inner reef lagoon of Clipperton is actually a brackish enclosed environment, with no connection with the surrounding sea (Glynn *et al*., 1996). Evidence of active reef growth in the recent past (Sachet, 1962a; Carricart-Ganivet and Reyes-Bonilla, 1999) may be explained by the existance of at least two channels before 1900. One located on the northeast part of the atoll and the other one on the southeast zone connected the reef lagoon with the surrounding sea (González Avelar, 1992; Glynn et al., 1996).

The eastern-most atoll in the Pacific Ocean, as well as the most remote territory on the Tropical Eastern Pacific Zoogeographic Province

Overall, the species of the atoll are mostly American colonists, with an important component of Indo-Pacific taxa also present (Robertson and Allen, 1996). Clipperton has high endemism but an impoverish fauna including only 18 species of coral (Glynn *et al*. 1996, Carricart-Ganivet and Reyes-Bonilla, 1999). This, combined with its biogeographic location, extreme isolation, small size make

Table 1 Main historic happenings on Clipperton (modified from González Avelar, 1992)

1526	November 15. Spanish vessels, commanded by Alvaro Saavedra, sailed from New Spain (now México) and discovered Clipperton Atoll.
1665	A commercial route from Philippines to New Spain was established, making Clipperton a landmark for travel in the Pacific for almost 250 years.
1705	In February the pirate John Clipperton visited the island, thinking he was making a discovery.
1711	April 3. French commercial vessels found the island and named it as the Île de la Passion. They went to Hawaii to registered it as a French discovery.
1825	The first official map of México, as an independent country, was published by orders of President Guadalupe Victoria. Clipperton Atoll appeared for the first time as part of México.
1826	Commercial exploitation of guano by a French-Mexican company began.
1897	The Mexican vessel Demócrata established a Mexican garrison at Clipperton.
1898	January 8. France officially disputed possession of the island with México.
1905	The Commander in Chief of the garrison, Abelardo Dávalos, is named Governor and political authority of Clipperton by the Mexican government.
1906	October 10. The Minister of France proposed submmission of the dispute for possession of the island to an international referee.
1908	Ramón Arnaud Vignon was named Commander in Chief of the Mexican garrison, now composed of 44 persons, including marines and their families. This year the guano extraction ended.
1914	The Mexican vessel Tampico, that used to transport food and water to the island, was sunk in Acapulco Port during the Mexican Revolution. Less than one month later, the American vessel USS Cleveland arrived at Clipperton and offered to evacuate the population. Arnaud and the rest refused to leave the island. During the following two years they received no communication from the mainland, and a number of deaths, caused by scurvy, accidents, etc., gradually reduced the number of survivors.
1916	Ramón Arnaud Vignon, the last Commander in Chief of the Mexican Navy garrison on the island, died tragically while in duty.
1917	July 18. The last survivors of the Mexican garrison (all of them women and children) were rescued by the American vessel USS Yorktown.
1931	January 28. Víctor Manuel III, King of Italy, awarded the possession of Clipperton Atoll to France.
1934	January 10. A modification to the 42nd article of the Political Constitution of México eliminated the island from the official territory of México.
1935	January 27. The French vessel Jeanne d'Arc took possession of the island.

Clipperton atoll a very interesting site for biological study.

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Coral Bleaching in the Maldives (Ari Atoll)

During the last decade wide areas of the Indo-Pacific and Atlantic reef provinces have experienced coral bleaching, but no extensive bleaching had been reported in the Maldives until 1998. Despite crown of thorns outbreaks and coral mining, the majority of the reefs flourished in good health until the bleaching event of 1998 (for a colourful description of the reefs see Ciarapica and Passeri 1995 and **Bookshelf**).

Since mid-1995 we have assessed reef conditions in the southeastern part of Ari Atoll, near the Kuda Rah resort (Holiday Club Maldives). Sea surface temperatures on April 21, 1998 were near 29°C; and by the end of April and the first half of May had risen to 32-33°C. Many corals bleached and experienced subsequent mortality. Scuba instructors reported coral bleaching in the middle of the Ari Atoll (Halaveli) at the end of April 1998, and in the NW (Ganghei) and SE parts (Kuda Rah) during May. Underwater video data from Kuda Rah area showed continued coral bleaching to depths of 15-20 m in August.

In April 1999 we revisited the SE part of Ari Atoll. Bleaching had been followed by extensive mortality of the shallow water coral colonies, both in the external ring of the atoll and in the internal faros. Algae and tunicates now dominate on the dead coral colonies, however the hard coral genera response to the bleaching event was variable and is briefly reported below.

No living colonies of once locally abundant *Millepora* (fire coral) were found. *Distichopora* (lace coral) was in good health but is not considered to be an important reef builder. *Heliopora coerulea* (blue coral) was common in shallow water but not abundant, with only a few colonies in the reef flat showing partial disease. *Heliopora* was abundant on the outer reef.

Pocilloporidae, which were previously abundant on the reef flat and the upper slope, have suffered. No living colonies of *Seriatopora* and *Stylophora* were found; almost all *Pocillopora damicornis* and *P. verrucosa* were dead in shallow water but many living *P. verrucosa* colonies were observed below 10 m depth.

Acroporidae - all *Acropora*, formerly the most important wave resistant reef builders, were dead in shallow water (*Acropora* (*Isopora*) and *A. robusta* group, *A. formosa*, *A. horrida*, *A. aspera*, and *A. nasuta* groups). Some living colonies of *A. danai* and *A.* (*Isopora*) *palifera* were found, but only in the submerged reef, north of Diggurah, at 10 m depth. The *A. humilis* group was once very abundant on the reef flat, yet only a few colonies have survived in deeper waters. Formerly abundant on the reef flat, *A. hyacinthus* and *A. divaricata* groups survived with partial damage at 10-15 m depth. Similarly, the *A. selago* (*A. tenuis*) and *A. latistella* groups were found living only below 10-15m. The incrusting and foliose forms of *Montipora* have survived in shallow water where they represent the most common living hard coral. *Astreopora* was in good health in both shallow water and below 10 m depth.

Algae and tunicates now dominate on the dead coral colonies

Of Agariciidae, *Pavona minuta*, *P. varians* and *P. venosa* were still living on the reef flat. *Pavona*

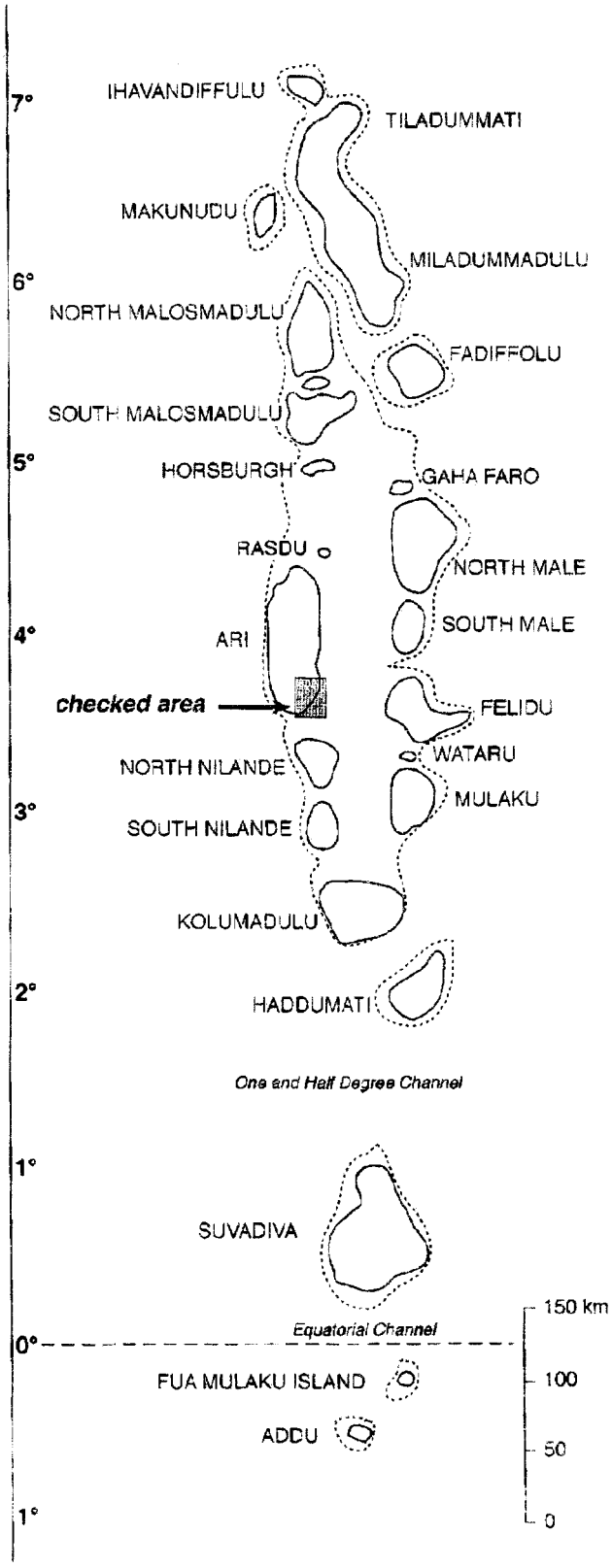

Fig. 1 General location of Ari Atoll

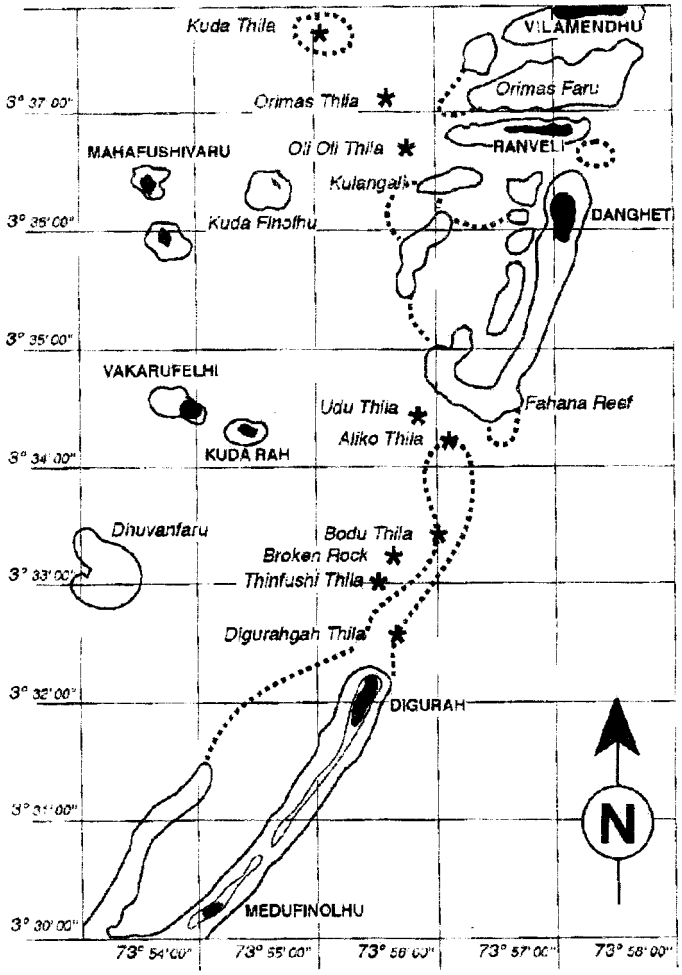

Fig. 2 Locations of sites mentioned in text.

clavus was the most important Maldivian reef builder among the Agariciidae. Living colonies were found, however mortality of the foliose forms of *Pavona* and *Gardineroseris* exceeded 50%. Living colonies of *Leptoseris* and *Pachyseris* were present below 10 m.

Thamnasteridae - *Psammocora* colonies survived in shallow water, but we have no data to evaluate percentage mortality.

Mortality among the mushroom corals (Fungiidae) was difficult to evaluate, but individual or colonial genera of this family were often the most common living corals in shallow water. Although rare specimens showed white parts, the Fungiidae were not heavily damaged by the bleaching event.

Poritidae - *Porites* were an important Maldivian reef builders but mortality among the boulder morphologies of *Porites* was approximately 75% down to 15-20 m depth. Rare colonies in very shallow water (0.5-3 m) were still living, while very large

colonies on the southern corner of Fahana Reef were heavily damaged down to 15 m. Only a few living colonies of branching *Porites* were found on the upper slope. Many colonies of *Goniopora* were still living but no specific data were available.

Twenty-five percent of the Faviidae survived but were heavily damaged. The most common and resistant genera were *Diploastrea*, *Hydnophora*, *Favites*, and *Favia*. *Plesiastrea*, *Leptastrea*, *Cyphastrea*, and *Goniastrea* were relatively rare and many colonies were left partially living. Among the brain corals, *Platygyra* was destroyed (no living colonies encountered), while only some colonies of *Leptoria* survived. *Echinopora* shows the highest mortality among Faviidae with total mortality in shallow water and heavy damage to 20-25 m depth, especially in Oli-Oli Thila.

Oculinidae - *Galaxea* was relatively rare, but some colonies were still living.

Merulinidae - *Merulina* were not abundant and are now only present below 10 m depth.

Twenty-five percent of *Lobophyllia* and *Symphyllia* (the most common genera of Mussidae on Maldivian reefs) survived, but colonies were heavily damaged.

Genera of the Pectiniidae family were not important as reef-builders and living specimens were found below 10 m depth along the reef slope and at the foot of jutting out walls.

Caryophylliidae - Bubble corals (*Plerogyra*, *Physogyra*) were rare and apparently were not damaged by the bleaching event.

Dendophylliidae - The zooxanthellate genus *Turbinaria* was only partially damaged with mortality estimated to be lower than 50% above 10 m depth. Azoxanthellate *Tubastrea micrantha* were flourishing and abundant along the passes between the marginal faros. *T. coccinea*, *T. aurea* and *Dendrophyllia* covered the walls and roofs of caves and were also present in very shallow water.

Bleaching related mortality was also observed in soft corals from the surface down to 15 m. Only a few colonies of leather corals *Sinularia*, *Lobophyton* and *Sarcophyton* survived while the fully colored *Dendronephtya*, *Scleronephtya* and *Siphonogorgia* were still common in the reef caves and slope below 10 m depth.

The damage was compounded by unusually large aggregations of the corallivorous gastropod *Drupella cornus* which were seen actively feeding on many of the surviving colonies of hard corals after the bleaching event.

Can coralline algae and boulder morphologies of Porites buffer the oceanic waves before the full recovery of the Maldivian reefs can occur?

If the bleaching event had the same effects on all of the Maldivian reefs (as seems very plausible), recovery will be problematic with some shallow living *Acropora*, disappearing completely from the Maldivian reef.

Following the bleaching event the most important reef-builders in the Maldives are red coralline algae and boulder morphologies of *Porites*. The question remains, can they buffer the oceanic waves before the full recovery of the Maldivian reefs can occur?

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CORDIO—Regional Research Program to Assess the Impact of the Coral Mortality in the Indian Ocean in 1998

Corals throughout the tropical oceans suffered heavy mortality between February and June 1998. The death of the corals was believed to be the result of the high water temperatures during the warmest year ever recorded on the planet. The extent and speed of the destruction was staggering. In many locations coral colonies over extensive areas suffered total mortality. Within three to six months reefs were transformed into areas covered by vast mats of fast growing macroalgae with the dead coral skeleton matrix beginning to break down in the process of transformation into rubble beds. The debate surrounding the secondary effects of the dying corals began late in 1998. The consequences to local coastal fisheries were of concern as well as impacts on tourism, coastal erosion etc. A number of research projects have been initiated to study these 'knock on' effects. One of these is the CORDIO program (Coral Degradation in the Indian Ocean) which was started early in 1999.

The Indian Ocean was particularly affected with morality rates frequently reported in the range of 75 to 90%

The degradation of coral reefs

The degradation of coral reefs around the world has been discussed for decades. Observations seem to indicate that today, in most relatively accessible areas where corals were common 50 to 100 years ago, only small pockets exist where reefs are reasonably healthy. Most reefs near coasts or inhabited islands have been degraded, often to an extent that perhaps less than 10% of the corals that used to be there, are still alive.

Although incidents of coral bleaching have been observed earlier this century, these have been localized and short lived. The bleaching which occurred in 1998 was unprecedented in magnitude. Reports came from all tropical regions and bleaching lasted for several weeks to months in some locations. The subsequent mortality was extensive. Several reefs in the East, Central and West Pacific, and the Caribbean suffered approximately 50% mortality or more (Wilkinson 1998). The Indian Ocean was particularly affected with morality rates frequently reported in the range of 75 to 90% (see below).

The goal is to provide information on the extent and speed of coral degradation in the Indian Ocean

There is no question that a general warming trend of the planet has led to the bleaching and death of corals in 1998. The year 1998 was the warmest year since temperature records have been kept, some 150 years ago. Similarly, the 1990s have been the warmest decade ever recorded, and with an exception of a 30 year long plateau between 1940 and 1970, the average temperature has been increasing throughout the entire century. Particularly during the last two decades there has been a constant rapid increase in temperatures. In addition to the global trends in increasing temperatures, 1998 was also a year of an extreme El Niño Southern Oscillation (ENSO) Event. Figure 1 attempts to illustrate the general trend in temperature rise, the coincident ENSO event, and the temperature when bleaching and mortality occur in corals.

The extent of bleaching in the Indian Ocean

Along the East African coast, bleaching resulted in mass mortality in many locations. At Kiunga in northern Kenya and Mafia Island in Tanzania, nearly all corals died in waters down to 10 meters depth. From other areas in Kenya, Tanzania and Mozambique, some reports were as low as 50% bleached coral cover, but bleaching was often near 100% on reefs in shallow water, and 50% or more in waters below 10 meters. Coral mortality was extensive along the East African coast and since the 1998 event coral cover appears to have been reduced to between 10 and 50% of previous levels.

There was also extensive bleaching throughout

the Seychelles, affecting 40-50% of the coral cover down to 23 meters at Aldabra Atoll, Providence Group and Alphonse Group, during March-May, 1998. The mortality of corals around the main islands of Seychelles - Mahé, Praslin and La Digue - was massive. Similar extensive bleaching and mortality occurred throughout most of the Maldives, Comoros, Chagos and Socotra, but fewer effects were seen further south in Mauritius, Réunion and Madagascar.

In India and Sri Lanka surface water temperature was approximately 35°C over extensive areas between April and June. Up to 90% of the corals died in many areas with total mortality on Bar Reef in Sri Lanka. In India, surveys reported between 50 and 90% mortality in the reefs in the Gulf of Mannar, Andaman and Lakshadweep Islands.

Assessment of the damage – the CORDIO Program

The goal of CORDIO is to provide information on the extent and speed of coral degradation in the Indian Ocean. At present the program supports close to 25 targeted studies and monitoring projects in 12 countries where ecological as well as socio-economic effects of the coral bleaching event are researched. Investigations focus on the natural recovery processes on different reefs, and methods for the damage mitigation and artificial recovery of reefs. In addition the program intends to support alternative livelihoods among local people affected by the coral mortality. Studies to investigate the socioeconomic impacts of the bleaching in coastal communities in affected areas and the effects on tourism (particularly the dive tourism) have also only just been initiated. During its first year the program received approximately US$ 1 million from the World Bank (through the Dutch Trust Fund), SIDA (Swedish International Development Cooperation Agency), the Swedish Council for Planning and Coordination of Research, the Foundation for Strategic Environmental Research and WWF-Sweden.

Projects studying the status of the reefs, including the signs of recovery or continued deterioration, are underway in Kenya, Tanzania and Mozambique, as well as throughout the Seychelles and Maldives archipelagos, Mauritius, Reunion, Comores, Sri Lanka, and the Indian reefs in Bay of Bengal (Andaman and Nicobar), Gulf of Mannar and the western Indian Ocean (Lakshadweep).

Projects to study the secondary effects on the fish communities and other reef organisms are being carried out in East Africa, South Asia and the Indian Ocean Islands. Preliminary results show that the fish communities associated with the coral reefs were affected, and herbivorous fish tended to increase in

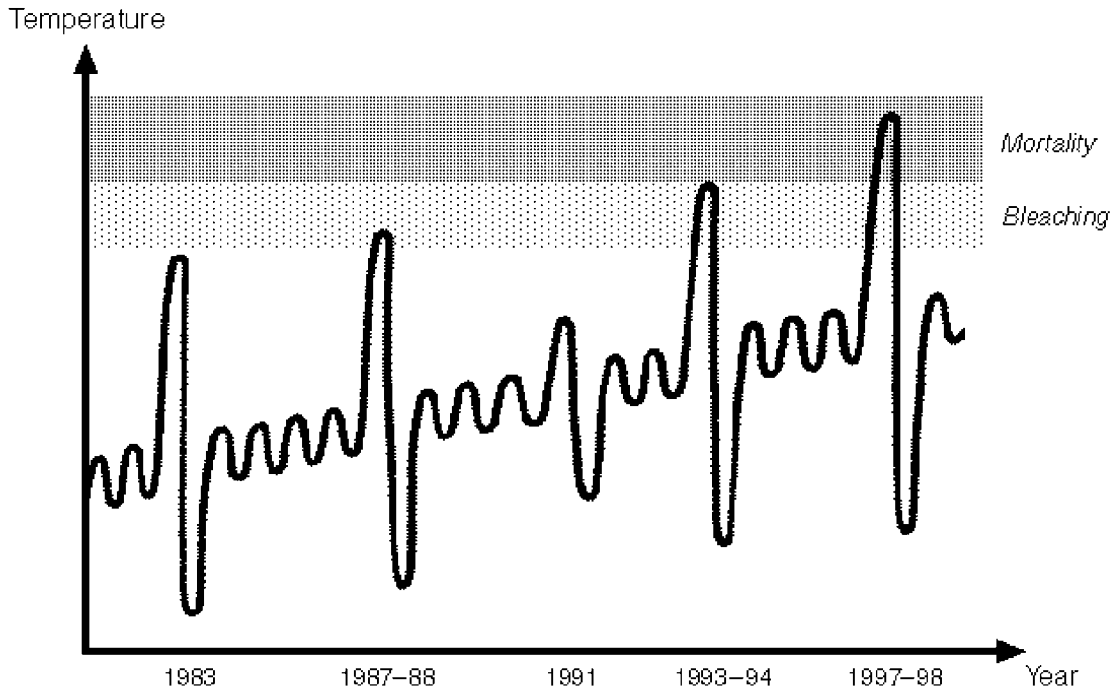

Figure 1. General trend in temperature rise, coincident ENSO events, and temperature thresholds of when bleaching and mortality occur in corals.

numbers while corallivorous species decreased. In some areas the entire reef fish communities (abundance and diversity) decreased to less than 25% of their former levels. Some studies also reported drastic reductions in butterfly fish numbers. Monitoring of potentially toxic, epiphytic dinoflagellates have shown drastically increased concentrations in areas with dead corals.

The implementation of projects under the CORDIO program is coordinated from three centers in the Indian Ocean Region (see below). The actual project, including field sampling, compilation of results etc. is carried out by almost 10 country teams. The initial country by country assessment of reefs in the Indian Ocean by CORDIO teams has been summarized in a recent publication entitled Coral reef degradation in the Indian Ocean: status reports and project presentations 1999. Details of this document can be found at www.cordio.org .

CORDIO organization and implementation

CORDIO Steering Group - Representatives from the funding agencies.
Program Planning and Coordination - Ms. Indu Hewawasam (World Bank) & Mr. Olof Lindén, Stockholm University).
CORDIO East Africa - Dr. David Obura, CORDIO, Mombasa, Kenya.
Country teams: Kenya (Dr. Obura); Tanzania (Mr. Christopher Muhando); Mozambique (Ms. Helena Motta).
CORDIO Central Indian Ocean Islands - Mr. Jean Pascal Quod, CORDIO, Saint Denis, Reunion.
Country Teams: One team for several of the islands (Mr. Quod); Seychelles (Mr. John Collie).
CORDIO South Asia - Dr. Dan Wilhelmsson, SACEP/CORDIO, Colombo, Sri Lanka.
Country Teams: Sri Lanka (Mr. Arjan Rajasuriya);India (Mr. M.W.M. Wafar, Goa); Maldives (Mr. Jadullah Jameel).

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Wilkinson CR (1998) The Status of Coral Reefs of the World. Australian Institute for Marine Science and Global Coral Reef monitoring Network, Townsville, Australia. pp 184

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UPWELLINGS

Tackling the Paper Parks Problem

Maggie Watson's article on 'paper parks' in the last issue (**Reef Encounter 25**, July 1999) was timely, as these are currently a topic of debate not only among those concerned with the marine environment, but also with those involved in forest conservation and protected areas in general.

A Management Effectiveness Task Force for protected areas

In 1998, the IUCN World Commission on Protected Areas (WCPA) set up a Management Effectiveness Task Force (METF) to work on the development of a system that will provide managers, planners and other decisions makers with methods for 'verifying' or 'assessing' management effectiveness. The term 'management effectiveness' encompasses both management of existing protected areas and the siting and design of new protected areas. The METF subgroup concerned with the management of existing protected areas – and thus addressing 'paper parks' - is chaired by Marc Hockings of the University of Queensland and is focusing on:

1. Promoting the use of monitoring and evaluation in protected area policy development, planning and management;
2. Developing appropriate guidelines and methodologies for assessing effectiveness;
3. Acting as a clearing house for related studies and information.

Assessment of management effectiveness can lead to improved management in a variety of ways. Protected areas under particular threat will be identified, so that funding, interventions and priority setting can be adjusted accordingly. Monitoring

and evaluation will result in better understanding of the causes of success and failure, allowing for adaptive management. It will also lead to greater accountability, and the results of assessments can be used as advocacy tools with governments and protected area managers, as well as to create publicity and put pressure on institutions that may be causing protected area degradation.

Several assessment initiatives are already underway. For example, WWF Brazil has assessed protected area management effectiveness in Brazil, and the Government of India has surveyed the management effectiveness of all India's protected areas. Both efforts used questionnaires and focused at the management or process level (e.g. funding, staffing, legislation etc). A more structured evaluation system has been developed by the Tropical Agronomic Center for Research and Higher Education (CATIE) and WWF Central America, based on work carried out in protected areas in Ecuador, Galapagos, and Costa Rica. Other assessment systems focusing more on monitoring of outcomes, in relation to objectives established through management planning, have been developed for individual protected areas (Tasmanian Wilderness and Fraser Island World Heritage Areas in Australia) and protected area systems (Sites of Special Scientific Interest in Wales, UK). The World Heritage and Ramsar (Wetlands) Conventions are also looking at management effectiveness of their respective sites.

METF will provide decisions makers with methods for 'verifying' management effectiveness

There are significant disparities worldwide in management capacity and large variations in the nature of protected areas, and so the METF will emphasise the need to ensure that the methods developed can be adapted to different needs across the full global spectrum of protected areas. More work is needed on generic 'outcome' indicators - i.e. measuring biodiversity conservation and socio-economic effectiveness, as assessment systems must ideally address these levels as well as the direct management level.

More work is needed on generic 'outcome' indicators

A set of draft principles has been drawn up by the METF for use in the development of assessment systems:

- Assessment systems should aim to be participatory at all stages of the process and should seek to involve all relevant organisations and individuals that may have an interest in the management and use of a site.
- Assessment should be based upon a transparent and comprehensible system. The findings should be readily accessible to all interested parties.
- The management objectives must be clearly defined and understood by the managers and assessors.
- Assessments of management effectiveness should focus on the most important issues – including threats and opportunities – affecting or potentially affecting the achievement of management objectives.
- Design, inputs, processes, outputs and outcomes should all contribute to an assessment system.
- Indicators should identify critical aspects relating to social, environmental and management issues, including the relationship between the protected area and its surroundings.
- Limitations of the evaluation should be clearly identified in the assessment report.
- The system should be capable of showing change over time through periodic assessments.
- In reporting on assessment, strengths and weaknesses should be identified and issues should be divided between those that are within and outside the manager's control.
- Assessment should allow prioritisation of conservation effort.
- Clear recommendations for management improvement should be included in all assessments.
- The methodology for evaluation should be progressively verified and refined as necessary.
- Assessments should be based on sound and appropriate environmental and social science. Assessment is likely to include both quantitative and qualitative information that should be supported by measurement or other evidence.
- Some form of quality control will be needed if assessment systems are to have credibility with the wider community.

The METF has prepared a discussion document Evaluating Management Effectiveness - a framework for evaluating management of protected areas which is being revised for publication. A num-

ber of other materials are being produced by IUCN, including a special issue of Parks (WCPA's international journal for protected area managers), and chapters in a new book on protected areas Partnerships for Protection (Dudley and Stolton, 1999).

Bringing Marine Protected Areas and coral reefs into the process

Although WCPA has stated that any verification system should be applicable to all types of protected areas, the focus to date has been on forests. For example, the joint forest programme of IUCN and WWF is helping the METF to finalise the principles and criteria, and is carrying out field tests at forest sites in Africa and Central America. It is now recognised that there is an urgent need to strengthen the marine component of this initiative.

Many of the assessment systems that have been developed are broadly applicable to Marine Protected Areas (MPAs), and several have been successfully applied to them (e.g. CATIE and Government of India systems, as well as national protected area assessments carried out by WWF Canada and WWF Australia). Others have encountered problems particularly where the methodology has been developed primarily with terrestrial protected areas in mind. As WWF Brazil found in its national survey, MPA managers had difficulties with the standard questionnaire which included questions such as 'have the boundaries been demarcated?'.

Measuring the success of management in the marine environment can be particularly difficult, time-consuming and expensive, because of the need for trained divers, more complex equipment than is often needed on land, and because of factors such as tides and weather which limit access to the field. The lack of fixed boundaries means that major threats are often from outside the MPA and are not under the control of the manager, and this must be taken into account in an assessment system. Many oceans and seas have been considered open-access areas (with exceptions of regions such as Oceania where customary tenure systems exist), which makes enforcement more difficult, and the lack of 'ownership' can lead to uncertainty about the long-term maintenance of an MPA. MPAs also have particular importance in relation to tourism and fisheries which must be considered in any assessment system, with suitable indicators and measures developed.

There are a number of activities that need to be undertaken:

1. Individuals and institutions with appropriate marine expertise should be brought into the process of developing principles and criteria for a verification system, to ensure that the particular attributes of MPAs are taken into consideration.
2. Specific methodologies for measuring management effectiveness of MPAs should be developed. This will involve collecting existing information and case studies, adapting existing methodologies, developing new methods where appropriate, and testing these systems within MPAs.
3. Dialogue on this issue should be encouraged within the MPA community, and case studies publicised and disseminated. For example, forthcoming marine meetings could be used as fora at which to promote this process and seek input.
4. Help is needed to ensure that the session on management effectiveness at the 2002 World Parks Congress has an appropriate marine component. This might include presentation of case studies or a specific guide to management effectiveness assessment methods for MPAs.

There is an urgent need to strengthen the marine component of this initiative

MPAs with coral reefs might provide a particularly good starting point for some of these activities. Monitoring methods are already well developed for the biodiversity level, through GCMRN, ReefCheck and other programs. The socio-economic monitoring manual currently being developed would also play a key role. The 9th International Coral Reef Symposium would provide a good venue for getting an initiative off the ground. Anyone interested in playing an active role should get in touch, and we can work with the WCPA METF to develop a process to take some of these ideas forward.

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Looking from a distance can reveal a bigger picture. In response to growing interest in remote sensing, our feature section includes articles on Landsat 7, SeaWiFs, an update on HotSpot research, and from Brazil an example of how remote sensing can help coral reef conservation.

Landsat 7: Long-term Large-scale Reef Studies

The decreasing health of reefs worldwide worries managers and scientists alike. To understand apparent changes over recent decades scientists need data on a comparable timescale, but data acquired consistently and frequently over more than twenty years are scarce. Satellite imagery can help in bridging the gap both in time and space.

For example, in the USA's Florida Keys hundreds of Landsat images are available dating from the early eighties. However, the Florida Keys are the exception in coverage, rather than the rule, and scientists interested in past images of other coral reef areas may be disappointed. For instance, only a few sites are covered before, during and after the 1998 bleaching events.

To avoid this situation in the future, the Remote Sensing Laboratory (Department of Marine Science University of South Florida), proposed that Landsat 7 focus on reefs worldwide through it's Long Term Acquisition Plan (LTAP). This idea has been welcomed enthusiastically by recent workshops on remote sensing of reefs organized by the Laboratory and the Center for Marine Conservation (St. Petersburg, Florida, February 1999), and by NOAA and ICLARM, (Honolulu, June 1999 – see **Meetings** for more information). The US Coral Reef Task Force has also backed the LTAP as a first step in implementing their strategy.

The overall goal of the LTAP is to build an archive of images for analysis of variations in land cover (vegetation, ice, desert…) in the context of global change (Goward *et al*. 1999). Nonetheless, interest in using Landsat to look at reefs is growing rapidly. In March-April 1999, nearly 70 coral reef scientists and institutions expressed interest in the Landsat images after a call broadcast via NOAA's coral-list-server. Based on these responses, we forwarded a request to the NASA Landsat Project to cover at least 4 to 6 cloud-free images per year for priority sites (standard coverage is about one image per year). Landsat 7 is now contributing to the following studies:

- mapping, biodiversity and resource assessment for Bermuda, Mexico and Oman coral reefs;
- assessment of chlorophyll and productivity from atoll lagoons in French Polynesia;
- an assessment of the impact of river run-off on coral reefs in South-East Asia and the Caribbean Sea;
- detection of change (bleaching, community phase-shifts) in the Indian Ocean, French Polynesia, and the Florida Keys;
- coastal geomorphological characterization of Hawaii and Maldive reefs;
- baseline mapping of all US reefs by NOAA.

At least 4 to 6 cloud-free images per year for priority sites

Landsat 7 was launched in April 1999, carrying the Enhanced Thermatic Mapper (ETM+) sensor (**Reef Encounter 25**, p. 17). The test-period was completed in less than 3 months and ETM+ started providing images in July 1999. Nearly 200 images are acquired per day worldwide, mostly over land targets. To date, nearly 20,000 images have been acquired and a significant number of these images cover coral reef areas. The process of systematic acquisition is well in progress.

The Landsat Project made substantial efforts to meet our requests at short notice just before the launch, and the project deserves recognition for this. Landsat images provide numerous opportunities for similar studies elsewhere, and future acquisitions may be scheduled in other areas if data already acquired is in demand. So what are the main scientific and management issues that can be addressed using regular data from Landsat 7 images?

We suggest a preliminary long-term agenda to answer three questions.

Question 1: What is the exact distribution of coral reefs ecosystems worldwide?

Information on reef location was the single most important request put forth by participants of the NOAA/ICLARM workshop. Indeed, despite a century of hydrographic work, several decades of satellite observations, and a few years of modeling, the surface area covered by reefs is still only a crude estimate. Despite constraints such as cloud cover and the repeat cycle due to the Landsat orbit, LTAP could provide a high resolution complete coverage of reefs within a few-years, provided support continues, and the mapping effort is networked and coordinated internationally, to complement the efforts produced by ICLARM and WCMC for ReefBase.

LTAP could provide a high resolution complete coverage of reefs within a few years

Question 2: What are the types of reefs and their structures at habitat, landscape and regional scales?

Hundreds of accurate description of reefs already exist, so what can remote sensing provide that fieldwork did not? Simply a scale of description not possible in space (and time) using standard fieldwork practices. The spatial resolution of Landsat 7/ETM+ is adequate for mapping and characterizing entire reef formations, including narrow fringing reefs that cannot be recognized with coarse resolution sensors such as SeaWiFS, AVHRR, or MODIS. Habitat mapping is the most frequent application of remote sensing for reefs and previous studies have clearly described what assemblages of bottom features can be distinguished accurately. Landsat data are perhaps most suitable for addressing the landscape (or seascape, or hydroscape) scale, a scale seldom investigated in the past but one that will be increasingly considered in the future for management purposes.

Question 3. What are the magnitudes of productivity and calcification processes at the scale of an entire reef system according to large scale environmental forcing factors ?

This last question differs from the previous two because most of the tools required to make this assessment (for example bio-optical algorithms linking reflectance, pigmentation and metabolism at a scale of few tens of meters, do not yet exist). This question, vital for a realistic estimation of the present and future state of the reefs at the global scale, needs to be addressed by several related research projects.

With the current studies NASA has taken a significant step towards answering these questions. We hope that the results will help better understand the structure and functioning of reefs at a scale usually not addressed. To make full use of this tool, we need the involvement of the larger coral reef science community.

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Goward *et al*. (1999) *Enhanced Landsat capturing all the Earth's land areas*, EOS Trans. AGU 80(26): 289-293.

Appendix:

Documentation on Landsat sensors:
http://ltpwww.gsfc.nasa.gov/IAS/handbook/handbook_toc.html

Landsat project:
http://landsat7.usgs.gov/
http://landsat.gsfc.nasa.gov/

Main Landsat data gateway:
http://edcimswww.cr.usgs.gov/pub/imswelcome/

Useful ordering info:
http://harp.gsfc.nasa.gov/~imswww/pub/imswelcome/imswww.faq.html
http://edcwww.cr.usgs.gov/landdaac/tutorial/tips.html

Current coverage since beginning July 1999:
http://landsat7.usgs.gov/currentcov.html

Landsat software:
http://ltpwww.gsfc.nasa.gov/LANDSAT/CAMPAIGN_DOCS/MAIN/Software.html

Image processing handbook:
http://rst.gsfc.nasa.gov/TofC/Coverpage.html

Non-exhaustive bibliography on remote sensing and coral reefs, and related subjects:
http://paria.marine.usf.edu/ftp/Serge/Biblio

Some L7 images on coral reef areas (quicklooks)

http://paria.marine.usf.edu/ftp/Serge/L7

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SeaWiFS Spies Reefs

Comprehensive surveys of the world's oceans are difficult and prohibitively expensive, and as a result, our understanding of the global distribution of coral reefs is limited and often incomplete or even inaccurate. The recent development of ReefBase (by the International Center for Living Aquatic Resources Management -ICLARM and the World Conservation Monitoring Centre - WCMC) provides a comprehensive digital database of reefs for the entire globe. But ReefBase was built, of necessity, from a wide variety and quality of charts and records, and has inherent inaccuracies and limitations. Improved information on depth, bottom type, and area could improve our understanding of reefs. Satellite data can supplement existing data sets by providing repetitive coverage, consistent sampling methods and access to remote and otherwise poorly observed regions of the planet.

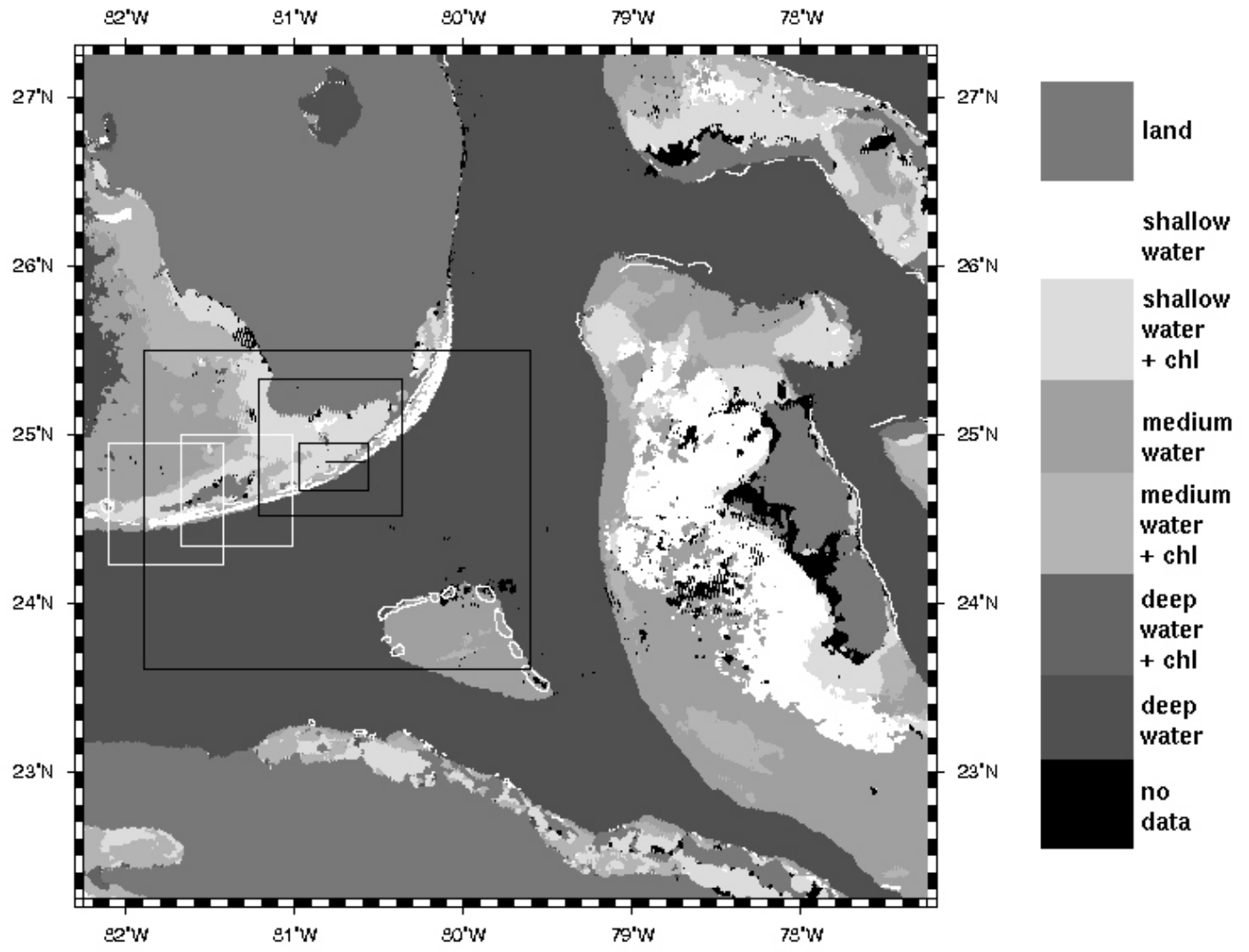
Several types of data exist, including thermal information, low resolution (9-50 km) and medium resolution color imagery (1 km), as well as high resolution imagery from Landsat, SPOT, Space Shuttle and aircraft. Thermal imagery is already used to research and monitor coral bleaching (Strong *et al*. **Reef Encounter 24**, p. 20-21 and Toscano *et al*. this issue). Ocean color imagery measures water constituents like phytoplankton chlorophyll-a, and also detects depth and bottom characteristics, particularly the presence of pigments.

SeaWiFS (Sea-viewing Wide Field-of-View Sensor), launched in September 1997, provides a unique opportunity to obtain global information on shallow water environments. The SeaWiFS sensor is designed for routine global monitoring of the color of the ocean and is a joint effort between NASA and Orbital Imaging, Inc.. Although specializing in chlorophyll measurement, the sensor can also extract depth and bottom characteristics. SeaWiFS has a field of view as narrow as 1.1 km per pixel, and potential repeat coverage of every two days in the tropics. With onboard storage capabilities and a network of over 65 high resolution receiving stations, SeaWiFS provides information for just about anywhere in the world, which is a critical factor in developing information on coral reef environments in remote tropical areas.

Since the launch, SeaWiFS data has been collected, processed, archived and distributed by NASA to researchers around the world. In collaboration with NOAA, a set of high resolution SeaWiFS imagery covering the regions of the world's oceans where coral reefs are found is being developed into a database of shallow water environments and benthic habitats. This database identifies land, three water depths (deep > 20-30 m, medium 20 m to 5 m, and shallow < 5 m) and areas with high and low chlorophyll. By working with WCMC, we are able to overlay coastlines and their 1 km database of reef locations on the satellite imagery (Figure 1). As new images become available, we update the database. We now have coverage of over 90% of the tropical ocean where reefs occur (between 35S and 35N). The current algorithm has limitations as chronically turbid water cannot be separated from shallow water, and dense bottom vegetation (seagrass or algae) may be classified as deeper than appropriate. These problems are minor in most areas, and will be resolved as we populate the database and tune the algorithm. The task is huge, and the final database image will be over 250 million pixels (36,000 by 7,000). By overlaying the ReefBase map on the SeaWiFS-derived depth classification, we hope to verify the existing map, identify potential reefs that may have not been included in the initial survey, and correct any inaccuracies.

We now have coverage of over 90% of the tropical ocean where reefs occur

In addition, as imagery from Space Shuttle pho-



SeaWiFS Depth Classification

tography (an important contribution through the Johnson Space Center), Landsat imagery, MOS imagery, aircraft photographs and other sources becomes available, we will add it to our database with direct access at the Web Site (http://seawifs.gsfc.nasa.gov/seawifs.html!). The SeaWiFS database has many uses. It will provide a reference to a wide range of orbit-based imagery (such as Landsat). The database will be linked to the NOAA HotSpot studies in order to improve analysis where depth may be a factor in coral bleaching. For regions with poor chart information, SeaWiFS can help check the position of reefs (it has an accuracy of 1-2 km at nadir). Finally, it is the first step in establishing detailed information on bathymetry and bottom characteristics in coral reef environments on a national and global scale. A high resolution mapping and monitoring effort is now being developed for US waters (http://coralreef.gov).

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New Analyses for Ocean HotSpots and Coral Reef Bleaching

In **Reef Encounter 24**, Strong, Goreau and Hayes described the "HotSpot" technique employed to identify and map areas of the global tropics where satellite-derived surface temperatures (SSTs) have exceeded a threshold of 1.0^{O}C above the warm season monthly mean temperature. The technique is highly successful in providing early warnings of coral reef bleaching linked to thermal stress. In 1997 and 1998, HotSpot mapping illuminated all areas of the tropics that were subjected to intense and prolonged warming, coral bleaching, and subsequent mortality. We have recently incorporated a new treatment of the HotSpot data to help study thermal stress as a primary cause of coral bleaching. Ninety day overlapping HotSpot accumulation maps (accessible from our main web page) create a Degree Heating Weeks (DHWs) Index relating the duration and magnitude of HotSpots to the timing of coral bleaching in the tropical oceans (Toscano *et al*. 1999). One DHW is equivalent to one week of SSTs one degree warmer than the expected summer-time maximum. DHWs determine the time and degree of accumulated thermal stress that leads to bleaching (although concurrent environmental factors e.g. low winds and direct sunlight may be essential to force bleaching).

A Degree Heating Weeks (DHWs) Index relates the duration and magnitude of HotSpots to the timing of coral bleaching in the tropical oceans

Retrospective DHWs accumulation maps also dramatically highlight those areas which experienced the most prolonged thermal stress in 1998 and clearly implicate temperature in the widespread extent of coral bleaching and mortality. Coinciding with reports of significant bleaching, Eastern Hemisphere accumulations showed 4-7 DHWs accumulated in the southern GBR between February 1 and April 30, 1998. Similarly, between February and April 1998, 4->16 DHWs accumulated in the equatorial Indian Ocean, with 3-4 DHWs north of the equator. Between March and May, the northern Indian Ocean amassed 4-8 DHWs near the southern tip of India, accounting for the mass bleaching in the Maldives, as well as >16 DHWs near NW Australia, where large areas like Scott Reef experienced massive mortality. SSTs recorded in 1998 indicated widespread and protracted HotSpots at higher levels and over larger geographic areas than at any time since 1982, even eclipsing the previous high observed in 1988.

We received numerous emailed reports in 1998 from all areas of the world describing bleaching in the field. We would like to collect numeric data in future correspondence to relate the timing of HotSpots to the onset of bleaching; so we have added a Coral Bleaching Reporting Form to our main web page. We also plan to link the field reports in real time on an interactive map, and to serve as a database for quantitative information on bleaching in specific areas.

HotSpot distributions are now mapped twice weekly on our main web page at: *http://psbsgi1.nesdis.noaa.gov:8080/PSB/EPS/SST/climohot.html*. Annual global HotSpot composite maps for 1982-1998 are available at: http://manati.wwb.noaa.gov/orad/al/hot_anual82_97.html., and retrospective animations of the distribution, timing, and evolution of 1998 HotSpots for specific regions (e.g. the Indian Ocean and Great Barrier Reef) affected by coral bleaching are provided at *http://psbsgi1.nesdis.noaa.gov:8080/PSB/EPS/SST/retro.html.* A new poster, showing a 16-year time series of annual global HotSpot composite maps, is available by request to the authors, or as a PDF file from *http://manati.wwb.noaa.gov/orad/experiment_fm.html*.

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Marguerite A. Toscano, Alan E. Strong, Ingrid C. Guch, NOAA/NESDIS/ORA/ORAD, 5200 Auth Road, Camp Springs, MD 20746, USA

Reef Conservation in Brazil: Remote Sensing and Ground Truthing

A protected area called 'APA Costa dos Corais', covering some 100 km of the Northeast Brazil coastal zone between the states of Alagoas and Pernambuco (09°46'30"S to 09°32'51"S), was established in 1997 by scientists from the Department of Oceanography at the Universidade Federal de Pernambuco (UFPE) and the Brazilian Environment Agency (IBAMA - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis). The area aims to protect the most diverse coral community in the South Atlantic and its associated marine fauna and flora from pollution, overfishing, sedimentation, and tourism impacts.

The Brazilian National Institute for Space Research (INPE - Instituto Nacional de Pesquisas Espaciais) and UFPE have joined forces to map the intertidal reefs and to investigate the impacts caused by coastal zone development using TM LANDSAT, HRV SPOT satellite images and field investigations.

Maida and Ferreira (1997) reported that the area is characterized by three lines of reefs resembling a fringing-reef system running roughly parallel to the coast along a relatively narrow shelf 30 to 40 km wide. Field observations showed that the second line of reefs, and some of the reefs found in the first line, are actually coralline-algal reefs formed by a dense and massive framework of crustose coralline algae exposed during low tide. Most of the reef surfaces investigated show extensive bioerosion due to the echinoid *Echinometra* sp. and are primarily covered by fleshy macroalgae and articulate calcareous green algae such as *Halimeda* sp.. A mixture of siliciclastic beach sediments and reef-derived grains are found partially covering reef tops located close to the shore.

TM LANDSAT and HRV SPOT data have been digitally processed using the software SPRING (freeware at *www.dpi.spring.br/spring*) with the aid of ground truthing. Preliminary results indicate that TM LANDSAT-5 images discriminated main sedimentary features up to 8 m depth. These include tidal sand flats formed close to river mouths, areas with patch reefs and mixed carbonate-siliciclastic sandy bottoms, intertidal and submerged reefs.

Classification applied to different spectral band combinations produced different levels of mapping detail, especially concerning the depth of submerged reefs and reef cover types of the exposed ones. A less detailed map, which presents estimates of total (submerged and exposed) reef area, could be achieved through completely unsupervised classification. An important feature of these reefs is the presence of eroded ridges which are found in almost all intertidal reefs we investigated. These eroded ridges are around 1 m high relative to the surrounding reef surface, forming a continuous structure both vertically and horizontally, and could be an indication of a higher mean sea level in the Late Holocene. This speculation is supported by the presence of similar structures found in the coralline-algal atoll Atol das Rocas, Northeast Brazil (Gherardi 1995; 1996). Eroded ridges from Atol das Rocas are 1.5 m above present-day mean sea level and were radiocarbon dated as 1500 ±45 conventional radiocarbon years before present (SRR 5531 - NERC Radiocarbon Laboratory, Glasgow, UK).

TM LANDSAT-5 images discriminated main sedimentary features up to 8 m depth

The coupling of multispectral images and field data has proved to be a powerful tool for the development of management and conservation efforts in large and complex protected coastal regions, such as the 'APA dos Corais'. The lack of detailed studies in this area makes this initiative of paramount importance, since it offers a synoptic view of the different ecosystems and integrates data gathered from several areas of research.

The coupling of multispectral images and field data has proved to be a powerful tool

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COUNTRY PROFILE

The Coral Reefs of French Indian Ocean Territories (FIOT)

There are seven French islands and island groups in the South-West Indian Ocean. **Mayotte** (a Collectivité territoriale with a status similar to an autonomous territory) belongs to the Comoro archipelago. Its two islands (around 10 Myr, totaling 375 km^2), are almost entirely surrounded by one of the few true double barrier reefs in the world, lying 3 to 15 km off shore (Guilcher 1971). The lagoon is one of the largest surrounding a high volcanic island at 1500 km^2 and encounters with turtles, dugongs and mating whales are not uncommon. **Réunion** is a French Overseas Department and has been part of the French republic since 1946. At three million years old, it is the youngest island of the Mascarene archipelago and has only 7.3 km^2 of fringing reefs. Les îles éparses (the scattered islands) are remote and uninhabited (apart from meteorological personnel). They are administered by Réunion.

They range from high volcanic islands to atolls and sand cays; but all possess coral reefs

Les îles Glorieuses, north of the Mozambique Channel are four small coral islands on a 7 km^2 coral platform. The outer slopes drop steeply to at least 1500m, where *Halimeda* sand is abundant. Grande Glorieuse – (2.3 x 1.7 km) has 12m high sand dunes and a central marsh which dries at low water. These islands appear to be vestiges of ancient reefs, lying 3 m above sea level (Battistini and Cremers 1972; Stoddart 1967) and are linked by a large SW-NE orientated emergent reef flat. On this reef flat Vergonzanne (1977) sampled numerous invertebrate species including 309 molluscs and 36 echinoderms, however living corals are scarce. Yet on the outer slopes, Cousteau and Diolé (1971) found coral and fish communities were rich and diverse. The islands provide nesting sites for sea birds and green and hawksbill turtles. In 1973-74, almost 100 green turtles were observed nesting (Vergonzanne 1977).

Since the colonization of the Mascarene Ridge, terrestrial biodiversity on Réunion has continuously declined.

Far away from any coastline, **Tromelin** is a small pear shaped sandy cay (1 km^2) 6 m above sea level, surrounded by reef flats approximately 150m wide and with outer slopes dropping to 5000m (Delépine *et al*. 1976). The scleractinian fauna here appears poor with only 15 genera identified (Bouchon and Faure 1979). Bonnet (1985; 1986) and Hughes (1972) observed between 1500 and 2000 green turtles on the island, and most of these appeared to be nesting. These major turtle nesting beaches have been declared reserves (IUCN/UNEP, 1984). Colonies of breeding sea birds are abundant.

Juan de Nova, located in the middle of the Mozambique Channel, is a semi-circular island (5 km^2) at the center of a vast coral platform. Windward coral blocks (12 m high) are the predominant feature. The island was inhabited until 1967 when phosphate mining stopped. In spite of this history, sea birds continued to nest, and fish are abundant in the lagoon (Bonnet 1986).

82% of the population on Réunion live in coastal areas.

The almost circular atoll of **Bassas da India** (less than 1 km^2) barely emerges at low tide. The surrounding reef is approximately 13 km in diameter with a passage into the lagoon. Large expanses of dead coral and bare coral rock have been reported here.

Nearly circular, **Europa** (30 km^2) is 6 m above sea level at its highest point. A very shallow lagoon (<1 m deep) fringed with mangroves supports an abundance of fish (Malick 1976). A karst structure on the atoll rim reflects an older reef structure, and in many places reefs appear to be older rather than recent growth (Battistini 1966). Cousteau and Diolé (1971) reported a profusion of life on the outer slope to over 350 m. Europa's beaches are one of the most important breeding sites in the world for the green turtle, *Chelonia mydas* with 8,000 - 15,000 nests per year (Bonnet 1986; Vergonzanne *et al*.1976).

Threats

Réunion: Since the colonization of the Mascarene Ridge by the first Europeans in the 17th century, terrestrial biodiversity on Réunion, particularly bird and tortoise populations, has continuously declined. By comparison, coral reefs display a relatively high diversity considering their small size, with 149 species (55 genera) of scleractinians (Faure 1982) and more than 1000 species of fish (Letourneur *et al*. 1999). On the 2512 km^2 of emergent land area, human population in 1997 was estimated as 675,700, with growth of 1.8%, predicting a rise to 827,000 by 2010. Eighty two percent of the population live in coastal areas. A synergy of natural phenomena (i.e. cyclones and very low tides) and anthropogenic impacts, eg nutrient-rich submarine groundwater discharge, high sediment load in run-off water due to deforestation, pollution from household and commercial refuse, and from farming and industrial sewage affects the reefs. High visitor numbers and over-exploitation of resources are also prominent pressures. Fortunately, Réunion escaped elevated temperatures during 1997-98, and coral bleaching was less than 5% of the coral coverage.

FIOT reefs are incorporated into the French ICRI strategy.

Mayotte: Mayotte's population is increasing by 0.5% per annum. Protecting the last remnant areas of primary forests is a priority. Coastal degradation, marine pollution and over harvesting threaten the long-term viability and productivity of the fringing and barrier reefs. The black coral *Cirripathes*, is now scarce. Bleaching killed up to 80% of coral on the outer slopes (Quod 1999).

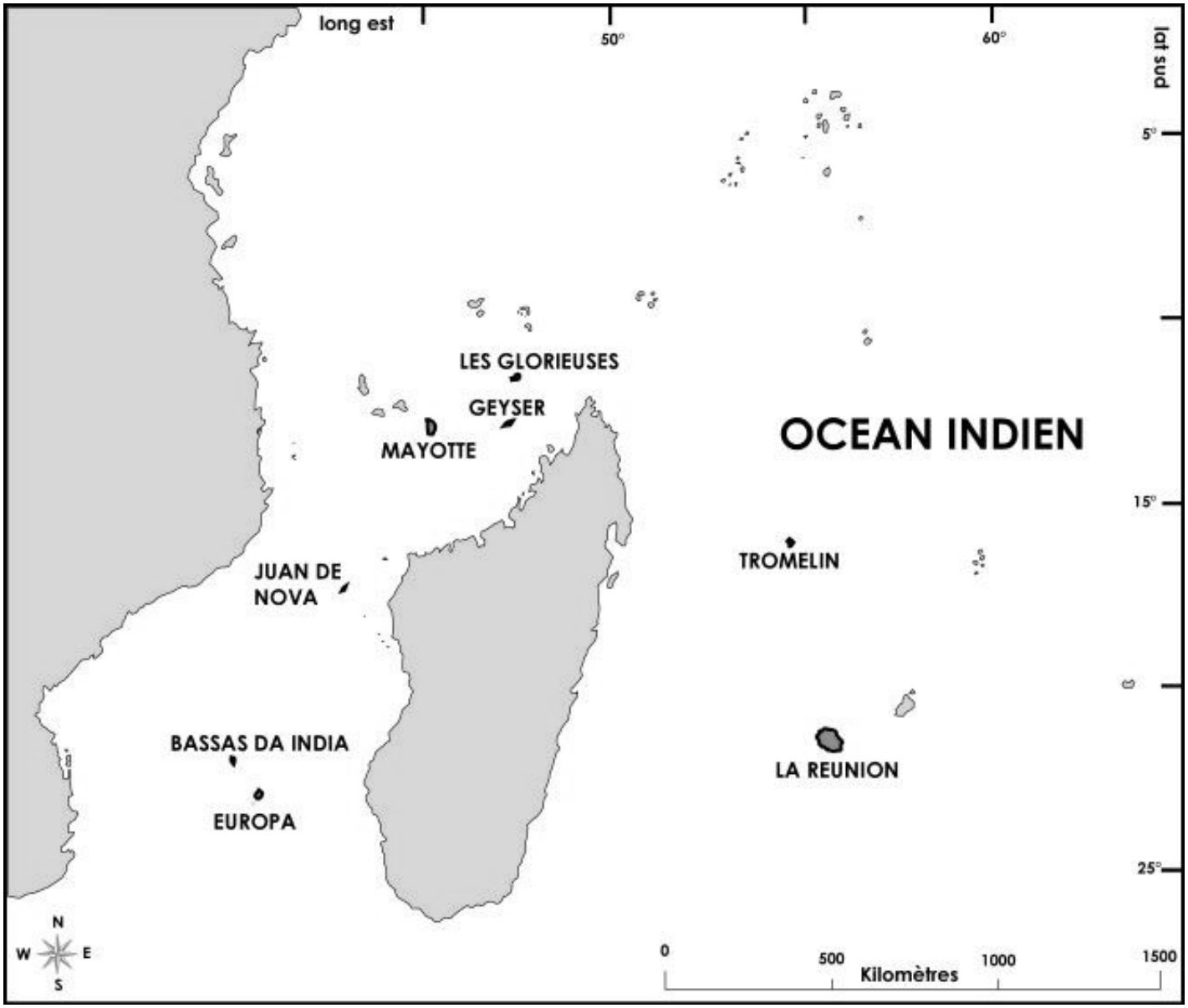
Anthropogenic threats to **Les îles éparses** are believed to be minimal. Localized pollution and the introduction of goats and rats may have had detrimental effects on the flora and fauna. Dunes are eroding on Gloriosa, and diving boats now visit, although the islands are natural reserves (Lecorre 1996; Troadec 1996). Anecdotal reports suggest 1998 coral bleaching was intense**.**

Research

Coral reefs have been studied intensely since 1967 by the University in Réunion, allowing a long-term evaluation of scleractinian and fish communities (synthesized in Naim *et al.* 1999). Most studies have centered on the Saint-Gilles/La Saline reef complex, (48% of the total reef flat on Réunion). Studies focus on degradation, restoration and threats to reef flats. Few studies exist for the outer slope due to unfavourable oceanography. On Mayotte, a Scientific Interest Group (GIS LAG-MAY) supports the local Fisheries and Marine Environment Service (DAFSPEM). Seabirds and turtles have been researched on Europa and Gloriosa (Lecorre 1998 and IFREMER - Institut Francais de Recherche pour l'Exploitation de la Mer).

Management and conservation

Eight monitoring sites on the reef flats and outer slopes of Réunion have become a node of the Global



Coral Reef Monitoring Network (GCRMN) through the regional environment program of the Indian Ocean Commission (COI). In Réunion, all coral reefs are protected, however the protection is not effectively enforced, leading to calls for a national nature reserve. The "Marine Park" NGO (a collaboration between the State, Regional and Departmental authorities, and the 9 municipalities) has managed the reefs since 1997. Two percent of the Mayotte lagoon is protected, including the Longogori Reserve (S-shaped pass) and the Saziley Peninsula (3100 ha. of lagoon, the barrier reef and 400 ha of the watershed). A Cetacean observatory is proposed and a Coral Reef Observatory established in 1998 carries out yearly monitoring at nine stations. Les îles éparses were established as Réserves Naturelles in 1971 and formally gazetted (except Juan de Nova) in 1975. More effective protection and the regulation of ecotourism is planned.

Education and the Future

The "Marine Park" on Réunion, and the DAFSPEM on Mayotte promote public education and awareness. A recently opened aquarium on Réunion educates by allowing direct observation of coral reef biotopes. The University teaches an introductory course on coral reef ecology. French Indian Ocean Territory coral reefs are incorporated into the French ICRI strategy (IFRECOR) on both conservation and management issues. Local committees in Réu-

Island	Latitude	Longitude
Iles Glorieuses	11°34'S	45°13'E
Mayotte	12°45'S	45°10'E
Tromelin	15°52'S	54°25'E
Juan de Nova	17°03'S	43°42'E
Reunion	21°10'S	55°29'E
Europa	22°21'S	40°21'E

nion and Mayotte are implementing this national strategy.

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SPYHOPPER

Appalled by all the fuss over calendars, Spyhopper has retired to his cramped lighthouse retreat. Morosely he strips away 1999 and uses each page to light his Y2K compliant lamp. By day, Spyhopper shuffles his archives, futilely attempting to order thoughts and scribblings. In doing so, he unearths some exceedingly interesting drawings, long forgotten and ignored. Vainglorious, he imagines your breathless anticipation. The blueprints of an extraordinary device unroll in a puff of 16th century dust. Although still undergoing tedious validation, Spyhopper believes they represent the work of a certain L. da Vinci. Spyhopper eschews polar metaphors and compares the importance of Leonardo's previously know work to a lone palm atop a large atoll. Overcome with a sudden admiration for technological advancements Spyhopper hooks up his satellite fax, and transmits the plans to his dedicated team of technologists. 'Leonardo's Lung' will be a literally breathtaking device for existing underwater. "So what?" Spyhopper imagines the Nobel committee's query. "Don't we have SCUBA for that?" Admittedly, but Leonardo's Lung is quite different. A cunning counter-current exchange, most remarkable in nature, will extract breathable gases from water. This silent mechanical gill permits indefinite submersion, at infinite depths, without fear of harmful nitrogenous products. The mechanism must remain secret, but Spyhopper lets slip that it involves high pressure recycling of bodily wastes. The only drawback is the current titanic proportions.

Thus, Spyhopper brings you clairvoyant thoughts on what might befall our beloved coral reefs in the next century. The future is a murky place, much like the increasingly polluted seas, and difficult to scry through. His predictions may seem preposterous, but Spyhopper braves the doubters, and offer you a vision of the future.

Looking at current trends, naturalistic coral reefs should be dead by 2050. In fact, it seems likely that the final blow will come from some postdoctoral researcher mapping out the distribution of remaining colonies who, desperately attempting to avoid a lungful of raw sewage, manages to crush the coral under surveillance with a flailing fin. Give up and enjoy natural reefs while you can exhorts Spyhopper. This is not to say that corals will disappear. Spyhopper knows of several large but secretive corporations developing artificial reefs and even artificial corals. Huge solar powered mobile platforms will roam the oceans adjusting themselves to optimal conditions for coral growth. These will be accompanied by remote harvester drones and who will maximise the platforms' contribution to human food requirements (what, you thought they were being developed for existence's' sake?!) by removing biological productivity in a trophically acceptable way.

Although still a prototype, the polynetic organism Artcropora™ will be the saviour of coastal communities worldwide. Made from slow-release saccho- and muco-plastics, each Artcropora™ polyp contains millions of active zooxthanthellae. Each polyp becomes a tiny sugar trap as carbohydrates are no longer absorbed by tissue. Colonies can be harvested, and the sugars removed whilst zooxs are recycled. Not only a food source, computer designed structural complexity will mean Artcropora™ reefs serve as optimal environments for other creatures, such as robotic fish. Surprised? You shouldn't be. Just as sheep need to be herded to pasture and slaughter, so too do fish. Japanese 'ranching' experiments are already well advanced.

More whimsically, Spyhopper predicts efforts to understand dolphin 'speech' will finally bear fruit. However, it will become immediately apparent that dolphin conversations are constructs of such enormous banality that human sympathy for these sleek and beautiful creatures will evaporate, and dolphin populations will be targeted for exploitation without mercy. Meantime, geneticists and physicists will miniaturise Leonardo's Lung, and *Homo marinus* will be born into the Age of Aquarius. A brave new ocean realm awaits us.

Outraged by the audacious Spyhopper? Reply care of the editor, address on back page.

BOOKSHELF

Annual Records of Tropical Systems

The record of changes in global climate as measured by satellites and a relatively dense network of meteorological stations is only on the order of 50 years long. In order to extend this record further back in time, and thereby capture the full range of natural climatic variability, proxy climate records are used. One valuable proxy record of past sea surface temperature and salinity conditions is contained in annual banding of many ocean corals.

The Past Global Changes (PAGES) core project of the International Geosphere Biosphere Programme (IGBP), in cooperation with the World Climate Research Program Climate Variability and Predictability Program (WCRP-CLIVAR) has recently published a booklet of recommendations for research on recovering such records entitled: Annual Records of Tropical Systems (ARTS) by Robert Dunbar and Julie Cole. The booklet is available in electronic format or hardcopy free of charge from the PAGES office on request.

The goals of the ARTS program are to:

1. document and understand the behavior of the tropical ocean-atmosphere and its teleconnections, with seasonal to annual resolution, over the past several centuries;
2. assess the stability of tropical climate systems and their teleconnections as the background climate and associated forcing phenomena change over seasons to centuries.

More information on the PAGES and ARTS programs, including downloadable pdf format of the ARTS report as well as an online hardcopy publication request form, can be found on the PAGES website: www.pages.unibe.ch

Dr. Keith Alverson, PAGES International Project Office Email: <keith.alverson@pages.unibe.ch>

Maldives: Coral Mountains

Gloria Ciarapica and Leo Passeri

This text illustrates the main reef-building genera of scleractinians in the Maldives. Specific attention is directed towards carbonate-producing organisms such as corals, molluscs, echinoderms, sponges, algae and foraminifera. Geographic aspects of the Maldives and the geological evolution of the area are illustrated with simple text, pictures (taken between 1990-95) and drawings. There are only 200 copies avaliable (1995 pp 127 + 172 figures, text is in Italian and English, US $ 24.00+postage). Copies can be ordered from BE-MA ed., Via Teocrito 50, 20128 MILANO Italy Tel +39 22552451 Fax +39 2 27000692 Email: <segreteria@bema.it> Web Site www.bema.it.

New Website for Florida Keys National Marine Sanctuary

http://www.fknms.nos.noaa.gov.

The Florida Keys National Marine Sanctuary is a 9500 square kilometer multiple-use marine protected area extending from Key Largo to the Tortugas. The Sanctuary protects a diverse array of habitats. The Florida Keys National Marine Sanctuary is committed to achieving a balance between resource protection and multiple, compatible uses of Sanctuary resources.

In the new and improved web site, visitors can familiarize themselves with the Florida Keys and the Sanctuary through a wealth of information on topics such as volunteer opportunities, regulations, and current research. Also on-line is a clickable map of the Sanctuary and adjacent waters. From this map visitors can click on a specific area of interest and gather information concerning zone type, GPS coor-

dinates, regulations governing activities in the area, as well as current research being conducted at a particular site. On-line information is also available on obtaining research and other permits to conduct specific activities within the Florida Keys National Marine Sanctuary.

Benthic Habitats of Puerto Rico and the U.S. Virgin Islands

http://biogeo.nos.noaa.gov/benthicmap/caribbean/

The Benthic Habitats of Puerto Rico and the U.S. Virgin Islands mapping project has made significant progress towards producing comprehensive digital maps of the benthic resources (e.g. coral reefs, seagrass beds) of the U.S. Caribbean. This NOAA led project which began in February 1999 is now in the data evaluation phase, and draft maps for a "test area" should be available shortly. The website (above) provides progress reports on the status of this project. Links to baseline data (e.g. shorelines), related websites (e.g. U. Puerto Rico, Coral Reef Task Force), and digital aerial photographs are also included.

International Workshop on Fisheries Co-Management, 23-28th August 1999

Some of the papers presented at the International Workshop on Fisheries Co-Management held at Berjaya Georgetown Hotel, Penang, Malaysia (23-28 August 1999) are available at <http://www.co-management.org>. A workshop proceedings will be published with information on coastal resources co-management, resource use, limitations and problems in Asia and Africa, and policy directions. The proceedings will include workshop papers, summaries of the sessions and their discussions, workshop conclusions and recommendations, list of participants and sources of further information.

Coastal Regions and Small Islands Web Site

http://www.unesco.org/csi

Information on the following "Caribbean" publications, documents and articles can be found at the Coastal Regions & Small Islands (CSI) website or from CSI Documentation Centre, UNESCO, 1 rue Miollis, 75732 Paris cedex 15, France, Fax: +33-1 45 68 58 06/08 Email: <csi@unesco.org>

Coping with Beach Erosion, by Gillian Cambers. UNESCO, 1998. A manual for specialists and non-specialists alike.

Managing Beach Resources in the Smaller Caribbean Islands. Papers presented at a workshop in Mayaguez, Puerto Rico, October 1996

Coasts of Haiti - resource assessment and management needs, 39 p

Planning for Coastline Change - guidelines for construction setbacks in the eastern Caribbean Islands, 14 p.

Coast and Beach Stability in the Caribbean Islands – COSALC project activities in 1996-97. 49 p.

Fisher to fisher - a grass-roots approach to improved fishery management, 14 p.

Haiti - bringing the sea back to life, 2 p.

The Mauritius Marine Conservation Society and Artificial Reefs

The Mauritius Marine Conservation Society (MMCS) subscribes to the World Conservation Strategy philosophy and acknowledges the urgent need to conserve the coral reef and lagoon ecosystems of the Mauritian islands (Indian Ocean). Our coral reefs contain the highest biological diversity of all our ecosystems and are important both ecologically and economically, as major tourist attractions, as a local recreational outlet, and in support of an overexploitative fishing industry. The MMCS was formed in 1979 by divers concerned about the degradation of Mauritian reefs. Important goals of the MMCS are to create public awareness of the need for marine conservation, to establish artificial reefs, and to generate support for the creation of marine parks.

MMCS is a NGO formed in 1979 by divers concerned with the degradation of Mauritian reefs.

At its formation twenty years ago, the MMCS recognised population growth, industrialisation, agricultural fertilizers, spearfishing, live shell collection and explosive fishing as the prime causes of marine environment degradation. It accepted the need for specialists to identify and quantify the degradation as this was beyond the capability of the MMCS. However, the role of public opinion, and awareness of the deteriorating situation in the lagoons and reefs by legislators were believed to be essential precursors to effective conservation of the marine environment. Our motto is Conservation Through Education.

It has become increasingly clear that the absence of the necessary laws and of an effective law enforcement vehicle are major constraints to the creation of marine reserves.

Artificial reefs have been created for centuries by fishermen intent on increasing their catch. Mauritius has installed many fish aggregating devices or FAD's around the coast since 1986, and the MMCS has sunk 13 vessels around Mauritius since 1980, in depths of 12 to 73 meters. An evaluation of the pelagic artificial reefs in Mauritius suggested these fish aggregating devices (FADs) could form a viable alternative to the over-fished lagoons for inshore fishermen. However, the debate as to whether artificial reefs increase biological productivity or merely concentrate marine life forms is not resolved. The MMCS has recently embarked on an evaluation of the artificial reefs, using underwater video and visual surveys. All artificial reefs but one have been repeatedly visited over the years since their creation. All 13 attracted pelagic fish species within weeks of their sinking. These all now harbour resident benthic reef fishes and pelagic fishes as well as crustaceans, molluscs and algal species. Most have been colonised by soft and hard corals, and the exceptions are believed due to depth and individual sites. The wreck structures are nearly completely covered with algal growth and harbour populations of small invertebrates. The artificial reefs in shallow water are particularly rich in attached fauna and have a species rich collection of associated fishes, commonly 30 to 50 species frequently numbering tens of thousands. Many local fishermen know of the artificial reefs and fish on them. However, regular use of the wrecks as sport dive sites has to a large extent altered the use from fishing to diving, through the social and economic interchange of fisherman for dive professionals and boatmen.

MMCS's initial aim was to ensure total protection of the wreck sites as "mini-reserves". However, lack

of control over fishing and diving put this idea to rest. It is increasingly clear that the absence of the necessary laws and of effective enforcement are major constraints to the creation of marine reserves. However, even with these in place, we believe that parties with vested interests, such as local divers, boatmen, fishermen, and hotels, will still need to co-operate for effective protection. The MMCS is currently fostering this co-operation and is gathering information available on artificial reefs in order to develop a thorough monitoring program.

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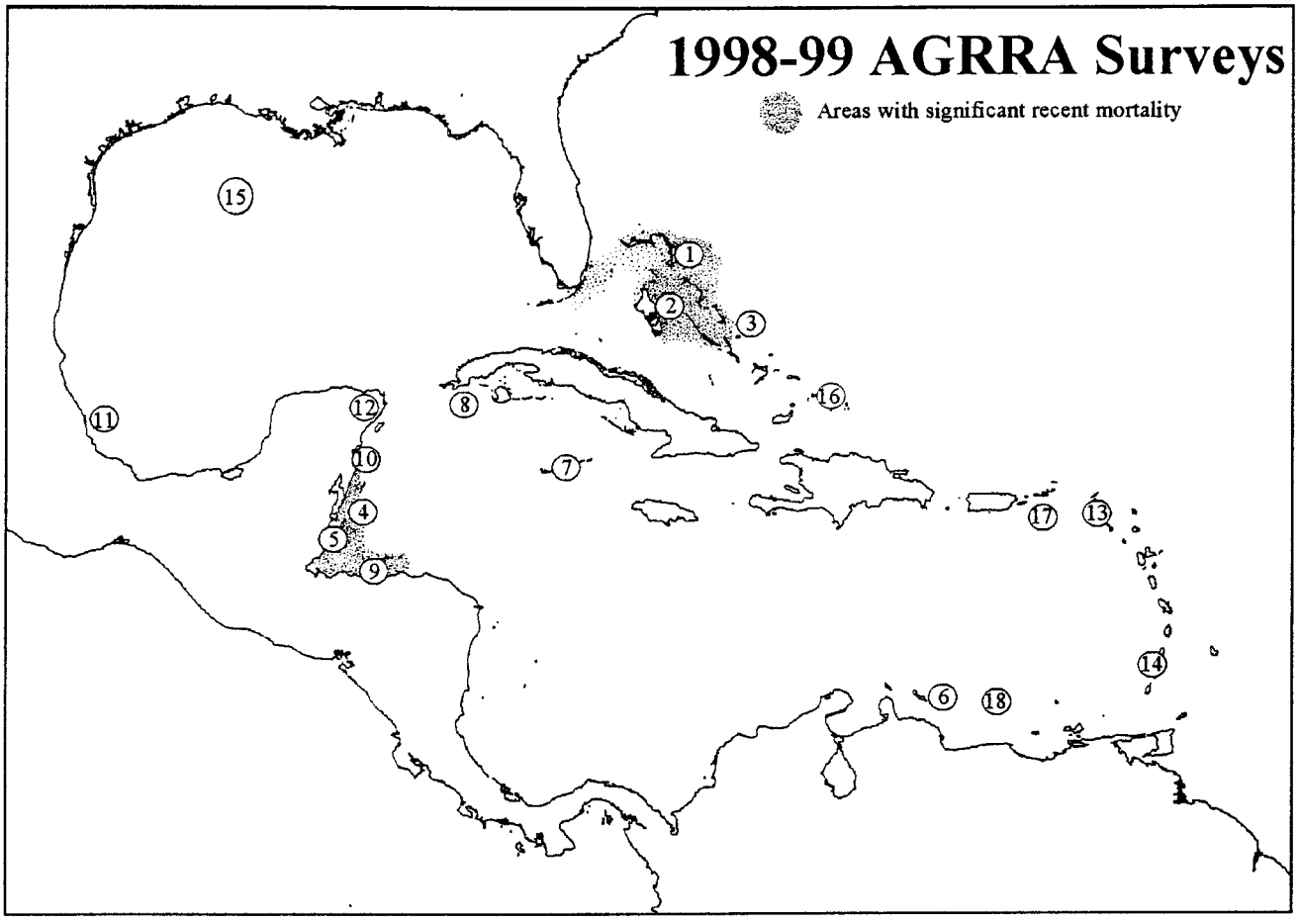
INTERNATIONAL INITIATIVES

Atlantic and Gulf Rapid Reef Assessment (AGRRA) Regional Update 1999

The AGRRA Program made substantial progress in 1998-99 towards building capacity and establishing a regional baseline of coral reef condition in the Western Atlantic and Gulf of Mexico. Training participants in applying the AGRRA Protocol is essential for capacity building as well as ensuring that assessments made by different teams are comparable. For these reasons, we organized two training workshops this past year. The first was for 12 participants in Bonaire, sponsored by the Bonaire Marine Park and



#	Area	Team Leaders	#	Area	Team Leaders
1	Bahamas, Abaco Island (13 sites)	Joshua Feingold, Nova Southeastern University	**10**	Mexico, Akumal/ Xcalak (12 sites)	Robert Steneck, Univ. of Maine & Judith Lang, Texas Museum
2	Bahamas, Andros Island (61 sites)	Philip Kramer & Patricia Kramer Univ. of Miami	**11**	Mexico, Veracruz (in progress)	Guillermo Horta-Puga & Guadalupe Barba-Santos, Tultitlan, MX
3	Bahamas, San Salvador (11 sites)	Paulette Peckol, Allen Curran, & Ben Greenstein, Smith College	**12**	Mexico, Yucatan (in progress)	J. Ernesto Arias, CINVESTAV-Univ. Merida
4	Belize, Lighthouse Reef (in progress)	Julie Robinson, Belize Audubon Society	**13**	Saba/St. Maarten (in progress)	Kristi Klomp, Michigan State Univ.
5	Belize, S. central region (9 sites)	Paulette Peckol, H. Allen Curran, Smith College	**14**	St. Vincent (5 sites)	Alice Deschamps & André Desrochers Univ. of Ottawa
6	Bonaire, Bonaire Marine Park (6 sites)	Philip Kramer, Univ. of Miami & Kalli De Meyer, Bonaire Marine Park	**15**	US, Flower Gardens (2 sites)	Christy Pattengill-Semmens REEF & Tom Shyka, NOAA's Nat. Marine Sanctuary
7	Cayman, Little and Grand (33 sites)	Carrie Manfrino, Kean Univ. & Bernhard Riegl, Univ.of Graz	**16**	Turks & Caicos (28 sites)	Carrie Manfrino, Kean Univ. & Bernhard Riegl, Univ.of Graz
8	Cuba, SW coast (4 sites)	Pedro Alcolado & Rodolfo Claro, Inst. Oceanol.	**17**	USVI (in progress)	Richard Nemeth, Univ. VI & Laddie Akins, REEF
9	Honduras, Cayos Cochinos- Bay Islands (9 sites)	Carlos Garcia, Cayos Cochinos Research Station	**18**	Venezuela, Los Roques (12 sites)	Estrella Villamizar Univ. Central & Juan Posada, Simon Bolivar Univ.

hosted by its director, Kalli De Meyer. The second, for 24 reef scientists from Central America, was sponsored by the World Bank/Netherlands Environmental Partnership Fund and held in Akumal, Mexico. These intensive five-day workshops combined numerous field exercises, presentations, hands-on data analysis, and discussions. The best measure of the success of these Workshops is that many of the participants have led or participated in subsequent AGRRA assessments.

Since June 1998, thirteen large-scale AGRRA assessments have been completed and the results are being prepared for publication. Short summaries of each assessment are posted on our Web Site (http://coral.aoml.noaa.gov/agra/). Below are some of the highlights from these surveys.

Many reefs of the Wider Caribbean are in relatively good condition:

- Intermediate-deep reefs of the Flower Gardens (USA), Los Roques (Venezuela), and Bonaire are in very good condition with all areas having high (40-50%) coral cover, large coral sizes, low macroalgae (~<20%), low recent mortality (~<2%), and good representations of fish populations.
- The majority of other areas surveyed (Cayman Islands, St. Vincent, Andros, Turks and Caicos, and Cuba) are in good condition but with some mod-

erate disturbances (e.g. overfishing, tourism).
- The Andros Island Reef System, some 150 km long contains remarkably healthy shallow reefs with extensive stands of living *Acropora palmata*.
- Old mortality of reef building corals is low to moderate (~20-30%) in most areas.
- Although much of the Caribbean experienced a major coral bleaching event in the summer/fall 1998, the majority of areas surveyed recovered with only minor coral mortality affecting selected species.
- Herbivorous fish (e.g. scarids and acanthurids) abundances appear moderate to high in most areas.

Selected reef areas are showing signs of disturbance and decline:

- Moderate to severe coral mortality was observed in portions of the Bahamas and in much of South Central Belize and Honduras associated with the 1998 bleaching event.
- Significant amounts of standing old dead *Acropora* occur in portions of Mexico, Bahamas, Turks and Caicos, Honduras, South Central Belize, and Venezuela.
- Coral diseases are moderate to high (>2%) in Belize, Honduras, and areas of the Bahamas and Cuba.
- Macroalgal abundances are moderate to high (>25%) in Belize, Honduras, Bahamas, Mexico, and Cuba.
- Herbivorous fish abundances are low in San Salvador, Bahamas; Cuba; and Mexico. Low abundances and smaller sizes of commercial fishes are found in these same areas, as well as in St. Vincent.

The majority of areas surveyed recovered from bleaching with only minor coral mortality

Next Steps

There are currently additional assessments underway in Mexico, U.S. Virgin Islands, Saba, Belize, Curaçao, and Brazil. Goals for the AGRRA Program over the next two years include collaboration of team leaders to synthesize data for regional comparisons of reef condition, developing a regional database accessible to all, and expanding assessments to additional areas in the region. The target date for completing the assessment of the Western Atlantic and Gulf of Mexico region is the end of the year 2001. AGRRA welcomes collaboration and partnerships with individuals and organizations interested in this large-scale effort.

Prepared by Robert Ginsburg and Philip Kramer for the AGRRA organizing committee. MGG/RSMAS, University of Miami, 4600 Rickenbacker Cswy., Miami, FL 33149. Email: <rginsburg@rsmas.miami.edu>

The International Coral Reef Action Network

A new umbrella project - ICRAN (International Coral Reef Action Network)-has been designed to reduce global coral reef degradation by facilitating the proliferation of good practices for coral reef management and conservation. ICRAN is now in its 'Start-Up' year and a four year action phase has been planned, for which the lead agencies UNEP (United Nations Environment Program) and ICLARM (the International Center for Living Aquatic Resources Management) are currently seeking funds.

The 'Start-Up' year will develop a strategic plan for the Action Phase, including the establishment of a "Coral Reef Fund". It will also include three initial activities in preparation for the Action Phase. UNEP will conduct an analysis of successful approaches to integrated coastal management (ICM) and marine protected areas (MPA) in Eastern Africa (also see **Upwellings** for news of how the IUCN World Commission on Protected Areas (WCPA) has set up a Task Force to tackle management of protected areas). The UNEP Regional Seas Program, through the CAR/RCU (Regional Coordinating Unit for the Caribbean Environment Program), will establish ICM and MPA training and demonstration sites in the Wider Caribbean. ICLARM will join with the World Resources Institute (WRI) and others in a Regional Reefs at Risk analysis focused on Southeast Asia - an analysis aimed at greater accuracy and usefulness at the regional scale than the 1998 global assessment. Amongst others, core partners are expected to include the International Coral Reef Initiative (ICRI) Secretariat, the Global Coral Reef

Monitoring Network (GCRMN — including Reef Check), the World Conservation Monitoring Centre (WCMC), the WRI, and the Coral Reef Alliance (CORAL). Partnerships are being developed at the regional and national levels, particularly through the activities of the UNEP Regional Seas Programme. The implementation of management practices supported with assessment, training and public information dissemination will be a crucial concept for the Action Phase. We hope to bring you more information on this major new initiative in the next issue of **Reef Encounter**.

Global Coral Reef Monitoring Network and Status of Coral Reefs of the World 2000

The GCRMN seeks your assistance to produce the `Status of Coral Reefs of the World: 2000' report. This will compliment the 1998 report which is freely available under a very relaxed copyright at www.aims.gov.au/scr1998 (and while you are about it, look up the companion home page www.ReefCheck.org). The report is a combination of about 50 national reports in around 15 regional chapters. During the 9ICRS (see **Diary** and **ISRS News**) National reports will be presented in a special poster session; Regional reports in a mini-symposium; and copies of the report will be offered for publication in the proceedings and available for distribution. Please assist your countries or countries you work in by providing data or by helping prepare reports.

The regional reports will be edited for non scientific readers and decision-makers, and published as the first biological report of GOOS – the Global Ocean Observing System (coordinated by IOC/UNESCO). Reports will also be presented to the Convention on Sustainable Development, Convention on Biological Diversity, and to Development Banks, bilateral donors, UN Agencies etc.

Unfortunately the Timetable to produce these reports is tight. Can you help meet these deadlines?

- All countries should assemble and analyse data into National Status Reports by 31th May 2000;
- All Regional reports will be compiled by 31st Jul. 2000, either through workshops for country coordinators or by e-mail collaborations;
- GCRMN and Reef Check Coordinators will write the 'Status of Coral Reefs of the World: 2000' report and send it to the publisher before 30th Sep. 2000;

Here is a suggested outline for the National and Regional reports:

STATUS OF CORAL REEFS OF (country)

1. **Introduction.** What and where are the reef resources, and how important they are to the communities and the country.
2. **Status of coral reef benthos**. Status of the reefs prior to 1998 with emphasis on the status of corals and other coral reef benthos (percent cover of corals, incidence of coral diseases, natural threats to corals etc.) and a summary of the impacts of the 1998 bleaching event (if any impacts) and current status of the reefs.
3. **Status of coral reef fishes**. Status of reef fish populations and fisheries including commercial, subsistence, recreational and aquarium trade.
4. **Anthropogenic threats to coral reef biodiversity**. An assessment of current and future anthropogenic pressures e.g. fishing, pollution, sedimentation, engineering activity etc.
5. **Current and potential climate change impacts**. For most countries, this will not be known, except in the case of the 1997-98 ENSO bleaching event.
6. **Current MPAs and monitoring / conservation management capacity**. A listing of protected areas and their status, including capacity in government and NGOs to manage these reserves.
7. **Government policies, laws and legislation**. This should include a listing of relevant laws and an indication whether there is harmonisation of these laws between different jurisdictions (National, State and Local) and across different government departments and sectors.
8. **Gaps in current monitoring and conservation capacity**. An analysis of gaps in national capacity, with particularly emphasis on those gaps that must be filled to advance coral reef conservation in the short-term.
9. **Conclusions and recommendations for coral reef conservation**. A summary of the status of reef resources and capacity to manage these into the future, and recommended actions that will improve reef conservation.

If you are able to assist please contact:
Clive Wilkinson, Coordinator GCRMN, c/o Australian Institute of Marine Science PMB No. 3, Townsville MC, 4810. Tel: +61 7 4772 4314; Fax: +61 7 4772 2808

Advances in Marine Sciences in Tanzania:

Zanzibar, 28 June-1 July, 1999

The University of Dar-es-Saalam's Institute of Marine Sciences (IMS) celebrated its 20th anniversary with a conference in collaboration with the Swedish International Development Agency (Sida-SAREC) and the Canadian International Development Agency (CIDA). The event brought together more than 100 scientists from the region, making it one of the major scientific events in the Western Indian Ocean for 1999.

The conference aimed to provide a forum for discussions and exchange of information on marine issues, to assess the importance of marine research, and to brainstorm on the future direction of marine research within Tanzania and IMS. The meeting also hoped to raise awareness of the Institutes activities, as well as marine environmental issues in general.

The proceedings will be published, covering a wide range of topics such as:

- **Setting the Stage - Marine Science Issues in the Region.** The session considered the history of marine sciences development, marine fisheries research and the importance of mangroves and coral bleaching.
- **Ecological and physiological processes in coastal ecosystems.** Recent studies have covered leaf litter degradation, nutrient release, microalgae, reproductive migration in the mangrove crab *Scylla serrata*, the pelagic microbial food web, cynobacteria species composition, meiobenthos nematode assemblage structure, ecology of the interdital zone, taxonomic research on macroalgae, photosynthetic tolerances of seagrasses, and reef fish communities.
- **Water quality and nutrients.** Work on the use of pesticides, organochlorine residues in water, heavy metal inhibition of calcification; temporal comparative studies in water quality and pollution status was considered.
- **Physical and Geological Processes.** The sediments around Zanzibar, sources of organic matter, sediment resources, reassessment of beach erosion along the Tanzania coastline, sea level variations, and the mobility and immobility of mid-ocean ridges made up the studies presented.
- **Marine research for development: Challenges for New Millennium.** A topic for reflection and discussions on the way forward.
- **The importance of the human dimension for marine and coastal resources.** This topic covered sustainable use of marine and coastal resources, mangrove and associated fisheries, restoration of mangrove and coral reef ecosystems by the local communities, dolphin tourism and community participation, impacts of tourism on women's activities, economic impacts of marine protected areas, development of community-based seaweed mariculture, problems and challenges with by-catch in the shallow water shrimp trawl fishery in Mozambique, and artisanal fisheries and coastal resources of Tanzania .
- **Marine and coastal resources: Sustainable management and utilisation.** There were opportunities to discuss biodiversity, management of marine resources by zoning, local community based training and education about the marine environment, East African databases and enhancing environmental awareness through marine education.

The conference allowed the participants to listen, think and exchange ideas and information on marine issues as well as to see how much has been done in the region. It also allowed us to see that much work is left to be done.

Maria Ascensao Pinto, Institute for Fisheries Research, P.O.Box 4603, Maputo, Mozambique.
For more information about the meeting or the proceedings, please contact
Institute of Marine Sciences,
University of Dar-es-Salaam, P.O. Box 668,
Zanzibar, Tanzania, Tel: 255-54-30741/32128
Fax: 255-54-33050
Email: <director@zims.udsm.ac.tz>

International Workshop on the Use of Remote Sensing Tools for Mapping and Monitoring Coral Reefs

7-10 June 1999, Honolulu, Hawaii.

The Workshop was attended by 75 researchers and managers representing the International Coral Reef Initiative (ICRI), the International Center for Living Aquatic Resources Management (ICLARM), NOAA, the Australian Institute of Marine Science (AIMS), Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO), the Great Barrier Reef Marine Park Authority (GBRMPA), and a variety of other government and academic institutions. CSIRO's Dr. David Jupp provided the Keynote Address, followed by a series of talks detailing the applicability of various remote sensing techniques to the study of coral reefs.

The preliminary Workshop Proceedings was made available July 1, 1999, at http://www.coral.noaa.gov/corvil/coral_reefs/index.html, and includes a 5-point "Resolution for Action" and a 13-Point "Recommendations for Action."

The 5 Resolutions agreed by consensus were to:

(1) develop accurate and precise base maps of all coral reefs at multiple scales to enhance reef conservation and management;
(2) form partnerships between government agencies, academic institutions, international and non-government organizations and the private sector to enhance the availability, transfer and utilization of remote sensing data and technologies, in order to facilitate the use of remotely sensed data by developing countries;
(3) develop a virtual facility to link together various remote sensing data sites with each other and with management-relevant data in ReefBase, the Global Coral Reef Database;
(4) establish a focused scientific program to improve utilization of current technologies, to develop new analytical approaches and technologies, and to bring research and developments associated with remote sensing into the tool kit of managers;
(5) encourage space agencies and private entities to maintain deployment of existing and relevant operational and research sensors on satellites or other platforms, (i.e. AVHRR, Landsat 7, SeaWiFS, Space Shuttle, Space Station, LIDAR etc.) and to initiate design and deployment of specialized technology for shallow oceans monitoring.

The final Proceedings document for the Workshop is scheduled to be published March 1, 2000. Further information from A. Strong and M. Toscano, NOAA/NESDIS/ORA/ORAD, Camp Springs, MD 20746 USA, 301-763-8102 Ext 170).

A Draft Program of Mini Symposia for the 9th International Coral Reef Symposium

This is a draft program of mini symposia drawn from the generous offers of more than 70 proposers. The Scientific Program Committee has tried to put together a program which is balanced and reflects the interests of the members of the **ISRS**. However, it is anticipated that some new titles may be added and some of those proposed below amalgamated depending on support from participants. The final program will be published in the registration circular which will come out approximately 6 months before the Symposium. Meanwhile updates will be publicized on the Symposium Web Page (www.nova.edu/ocean/9icrs)

A State of Knowledge

Large Scale Ecology of Coral Reefs: Linking Biogeography, Meta Communities and Local Ecological Dynamics. Convenors: Dr. Peter J. Mumby, Univ. of Newcastle, UK. Prof. Ronald H. Karlson, Univ. of Delaware, USA.

Planktonic Food Webs in Coral Reef Waters: Trophic Structure, Functioning and Interactions with Benthic and Pelagic Communities. Convenors: Dr. Jean-Pascal Torreton, Centre IRD de Montpellier, France. Dr. Bruce G. Hatcher, Dalhousie University, Canada, Dr. Bruno Delesalle, EPHE-CNRS, Perpignan, France. Dr. William M. Hamner, UCLA, CA, USA, Dr. Nathalie Niquil, University La Rochelle, France

Molecular Phylogeny and Population Genetics in Coral Reefs. Convenors: Dr. Serge Planes, Univ. de Perpignon, France. Dr. Giacomo Bernardi, Univ. of California, USA.

Why Do Zooxanthellae Live in Animal Hosts? A Symposium Honoring the Lifetime Contributions of Len Muscatine and Bob Trench. Convenors: Dr. Gisele Muller-Parker, W. Washington Univ. USA. Dr. William K. Fitt, Univ of Georgia, USA. Dr. Angela Douglas, Univ. of York, UK. Dr. Andrew Baker, Wildlife Conservation Soc. New York,USA.

Ecology of the Pelagic and Settlement Stages of Coral Reef Fishes. Convenor: Dr. Jeff Leis, Australian Museum.

The East Indies Triangle of Maximum Marine-Biodiversity: Definition and Origins. Convenors: Dr. B. Hoeksema, Natl. Museum of Natural History, Netherlands. Dr. Carden Wallace, Museum of Tropical Queensland, Australia. Dr. Moyra Wilson, Univ. of Durham, UK.

Lessons from the Past: Reef Palaeoecology and Its Applications. Convenors: Mairi Best, Univ. of Chicago, USA. Evan Edinger, Laurentian Univ. Canada. Dr. Markus Bertling, University of Muenster, Germany. Dr. Ben Greenstein, Cornell College, Iowa, USA. Dr. John Pandolfi, Smithsonian Institution, USA. Dr. Rachel Wood, Univ. of Cambridge, UK. Prof. Paul Sammarco of Chauvin/LA, USA. Dr Bill Kiene of SMNH, Washington, USA.

Reef Response to Rapid Climate and Sea Level Change During the Late Quaternary. Convenors: Dr. Paul Blanchon, Univ. of Mexico. Prof. Lucien Montaggioni, Univ. de Provence, France. Prof. Christian Dullo, Univ. Kiel, Germany.

Coral Reefs in Turbid Environments: Geological and Ecological Significance. Convenor: Dr. Piers Larcombe, James Cook Univ. Australia.

Reef Bioerosion. Convenors: Dr. Markus Bertling, Geol-Palaeo Inst. & Museum, Germany. Dr. Pat Hutchings, Australian Museum.

Hydrodynamics of Reefs and Modelling of Circulation in Lagoons. Convenor: Dr. Clifford Hearn, Australian Defence Force Academy.

Dust and Caribbean-wide Coral Reef Decline: an Hypothesis. Convenor: Dr. Gene Shinn, USGS, Florida, USA.

Caribbean Reefs 17 Years After Mass Mortality of Diadema antillarum. Convenor: Dr. Harilaos Lessios, Smithsonian Tropical Research Institute, Panama.

General Session – State of Knowledge. Convenor: **ISRS**.

B Resource Management

Designing Effective Coral Reef MPAs: Lessons Learned from Across the Sciences Around the World. Convenors: Dr. Leah Bunce, NOAA, USA. Mr. Arthur Paterson, NOAA, USA. Mr. Mike Mascia, Duke Univ. USA.

Large-scale Spatial Frameworks for Tropical Marine Conservation. Convenor Dr. Ghislaine Llewellyn, WWF, Indonesia.

Conservation Biology of Coral Reef Fishes. Convenor: Dr. Terry Donaldson, Univ. of Guam.

Global Priorities for Coelacanth Research and Conservation in the 21st Century. Convenors: Dr. Mark Erdmann, Univ. of California, USA. Dr. James Albert, Univ. of Florida, USA. Dr. Kasim Moosa, Indonesian Institution of Sciences. Dr. Wada Shideko, Indonesian Institute of Sciences/JICA.

General Session – *Resource Management*. Convenor: **ISRS**.

C Socio-Economic Issues

Bringing Social Sciences into Coral Reef Management: the Hows and Whys of Socio-Economic Assessment. Convenors: Dr. Leah Bunce, NOAA, USA. Dr. Nohora Galvis, ITC, Netherlands. Dr. Helge Vogt, Univ. of Bremen, Germany. Dr. A. White, UK.

Building Capacity for Tropical Marine Biodiversity Conservation: Case Studies and Lessons Learned from Different Approaches to Tropical Marine Ecosystem Management (includes stakeholder involvement, community based management, extension programs and networks). Convenors Dr. Ghislaine Llewellyn, WWF. Indonesia. Dr. Leah Bunce, NOAA, USA. Dr. Robert Pomeroy, World Resources Institute, Washington, USA. Dr. John Parks, World Resources Institute, Washington, USA. Mr. Ian Dutton, Proyek Pesisir, Indonesia.

Communicating Reef Science. Convenors Mr. Don Alcock, CRC Reef Research Centre, Australia. Ms. Jenni Metcalfe, CRC Reef Research Centre, Australia. Mr. Alex Ray Pal, Philippines.

Coral Bleaching: Assessing and Linking Ecological and Socio-Economic Impacts, Future Trends and Mitigation Planning. Convenors Dr. Lynne Hale, Univ. of Rhode Island, USA. Dr. Brian Crawford, Univ. of Rhode Island, USA. Dr. Barbara Best, US Agency for International Development, USA. Dr. Jamie Reaser, US Dept of State, Washington DC. Mr. Ian Dutton, Proyek Pesisir, Indonesia.

A Sustainable Trade in Marine Ornamentals: Linking Reef Science Conservation and Use. Convenor: Paul Holthus, Marine Aquarium Council, Hawaii, USA.

General Session: *Socio-economic Issues*. Convenor: **ISRS**.

D Assessment, Monitoring and Rehabilitation

Global Coral Reef Monitoring Network and Reef Check. Joint Symposium on Education, Monitoring and Management. Convenors: Dr. Clive Wilkinson, AIMS, Australia. Dr. Gregor Hodgson, Reef Check Global Survey Program, Hong Kong.

Central Questions, Experimental Design and Methods of Long Term Monitoring Programs: A Synthesis of Ecological Concepts and Data. Convenors: Dr. Brian Tissot, Washington State Univ. USA. Deborah Brosnan, Sustainable Ecosystems Institute, USA.

Coral Reef Biodiversity: Assessment and Conservation. Convenors Dr. Tim Werner, Conservation International, USA.

Coral Reef Restoration in the Next Millennium. Convenors: Dr. William Precht, PBS and J., USA. Dr. Richard Dodge, Nova Southeastern Univ. USA.

Remote Sensing and GIS in the Study of Coral Reefs. Convenors: Dr. John Hardy, Western Washington Univ. USA. Ms. Marji Puotinen, James Cook Univ. Australia. Dr. Eric Treml, NOAA, USA.

General Session – *Assessment Monitoring and Rehabilitation*. Convenor: **ISRS**.

E The Future of Coral Reefs

Global Climate Change and Coral Reefs. Theme 1 The science behind the prognostications of gloom. Theme 2 Bleaching, including 1998 Indian Ocean event. Theme 3 Solutions, socio-economic outlooks, management Implications. Theme 4 Undertaking and responding to projected sea level Changes. Convenor: **ISRS**.

Pathways for Land Based Sources of Pollution and Subsequent Impacts on Coral Reef Environments. Convenors: Dr. Christopher Reich, USGS, Florida, USA. Prof. Annadel Cabanban, Univ. Malaysia, Sabah.

Destructive Fishing Practices: Towards a Global Understanding of Causes, Effects and Management Solutions. Convenors: Dr. Mark Erdmann, Univ. of California, USA. Dr. Lida Pet-Soede, TNC, Indonesia. Dr. Jos Pet, TNC, Indonesia. Prof. Annadel Cabanban, Univ. of Malaysia, Sabah.

Coral Diseases: Pathogens, Etiology and Effect on Coral Reefs. Convenors: Dr. Laurie L. Richardson, Florida International Univ. USA. Dr. Richard Aronson, Dauphin Island Sea Lab, USA.

Coral Reef Non-indigenous and Invasive Species. Convenor: Dr. Lucius Eldredge, Pacific Science Association. Hawaii, USA.

General Session – *The Future of Coral Reefs*. Convenor: **ISRS**.

For further details contact:
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*Chair, **ISRS** Scientific Program Committee,*
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FAX: +61 7 4779 1400

First International Symposium on Deep Sea Corals

Science and Conservation of Deep Sea Corals. 30 July – 2 August, 2000, Halifax, Nova Scotia, Canada

This meeting is hosted by Dalhousie University and co-sponsored by the Ecology Action Centre, Dalhousie University, the Nova Scotia Museum of Natural History, the Canadian Ocean Habitat Protection Society, Science and Management of Protected Areas Association, World Wildlife Fund Canada, and the Department of Fisheries and Oceans, Canada.

Deep sea corals (such as *Paragorgia*, *Primnoa* and *Lophelia*) are widespread components of ocean ecosystems at moderate depths where current and

substrate conditions are suitable. There is growing evidence that they are foundation species for their associated biological communities and that these communities are inadequately conserved, partly as a result of ignorance of the importance of these corals. Recent evidence shows that fishing has had substantial impacts on these communities in both the North Atlantic and South Pacific. This Symposium will address the biology of deep sea corals, their communities and their conservation. The purpose of the Symposium is to review, discuss and synthesize all aspects of deep sea cold water coral biology, ecology, and fisheries science, including:

- worldwide distribution of deep sea corals
- technologies available to map coral distribution
- contribution of local, e.g. fishermen's, knowledge in determining distribution and status of corals
- climatic reconstruction using deep sea, cold water corals
- the biology of cold water corals including reproduction, recruitment, feeding and life span
- physical, chemical, and biological factors affecting coral distribution and growth
- deep sea, cold water corals and associated communities
- biodiversity and cold water coral ecosystems
- threats to deep sea corals, in particular the impact of bottom trawling and petroleum activities
- conservation measures, in particular MPAs/restrictions on destructive activities
- CITES listing of Scleractinian corals

Written work may be presented in English or French, but the meeting itself will be conducted in English. A registration fee of $150.00 Canadian dollars ($75.00 for students) is in effect until 1 June, 2000 after which the registration fee is $200.00. Individuals who find the full fee prohibitive but would like to attend are asked to contact the Secretariat.

Abstracts of 250 words or less must be submitted with the pre-registration form prior to 1 February, 2000. Changes to abstracts will be accepted until 1 June, 2000 when final abstract(s), early registration and associated fees are due. Abstracts must be submitted for both posters and oral presentations. Authors wishing to submit posters should clearly indicate so when submitting the provisional abstract(s). Electronic submission of abstracts to the Symposium Secretariat is acceptable and encouraged, provided all relevant contact information is provided. The papers presented orally at the Symposium will be published in a Proceedings volume. Papers submitted to this volume will be reviewed by the Scientific Advisory Committee for both content and style. Authors will be sent instructions on the format to follow in preparing their contributions upon receipt of registration. Authors will be expected to submit a final copy of their paper by July 30, 2000. Papers will also be considered from those submitting poster presentations. All authors will receive a complimentary copy of the proceedings.

Important Dates

1 February 2000 Pre-registration form, Provisional abstract. 1 June 2000 Final early registration fees due, Final abstracts. 30 July 2000 Final paper.

For more information, please contact the Symposium Secretariat : Susan Gass,
Ecology Action Centre,
1568 Argyle Street, Suite 31 Halifax,
Nova Scotia, B3J 2B3.
Email: <coral@is.dal.ca>
Tel: +1-902 429-2202 Fax: +1-902 422-6410

The *Shoals of Capricorn Programme* Opens its Doors to New Enquiries from Marine Researchers

The *Shoals of Capricorn Programme* is a major marine science research, training and education program run by the Royal Geographical Society (with IBG) in association with the Royal Society. Launched in the Seychelles in October 1998 and Mauritius and Rodrigues in February 1999, *Shoals* aims to develop the knowledge and skills for marine resource management and conservation. A *Shoals* web site has now been launched and can be located at www.shoalsofcapricorn.org

Facilities available currently include:

Ste Annes, Seychelles

- A small island off Mahé, in the Seychelles Marine Park.
- Staff accommodation for up to 4 full time staff + accommodation for up to 10 visitors.
- Air-conditioned office with three networked computers, colour laser printer, small library.
- Wet-lab and Dry-lab with drying oven, microscopes, desk space etc.
- Airconditioned training/meeting room with 3 networked computers.
- Dive store, with compressor, 6 full sets of diving equipment and small boats.
- Access to larger research vessels.

Rodrigues

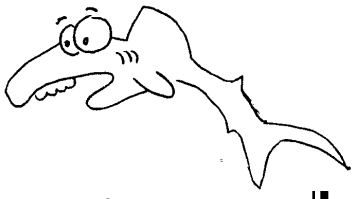
- Marine Resource, Education and Training Centre on the waterfront.
- Accommodation for up to 12, in three different houses.
- Two offices with 6 networked computers, colour laser printer, fax and e-mail facilities.
- Wet lab and dry lab, including microscopes, drying oven and general lab equipment.
- Interpretation centre, including AV equipment and reference library.
- Diving equipment and use of small boats available.
- Outside area to waterfront with equipment rinsing facilities; showers; aquaria; and touch tanks.

Peréybère, northern Mauritius

- Accommodation for up to 8 visitors.
- Access to diving equipment and small boats.
- Use of larger research vessels, small submarine (to 30m) and use of ROV can be arranged.

Please direct all enquiries to Shoals of Capricorn Programme Royal Geographical Society (with IBG), 1 Kensington Gore London SW7 2AR
Tel: +44(0)171 591 3066 Fax: +44(0)171 591 3031
Email <Shoals@rgs.org>

Compleat Reef Encounter



As scientists, do we always get our message across? How about this report title from a big international agency which had better remain nameless:

"Design and Implementation of some Harmful Algal Monitoring Systems"