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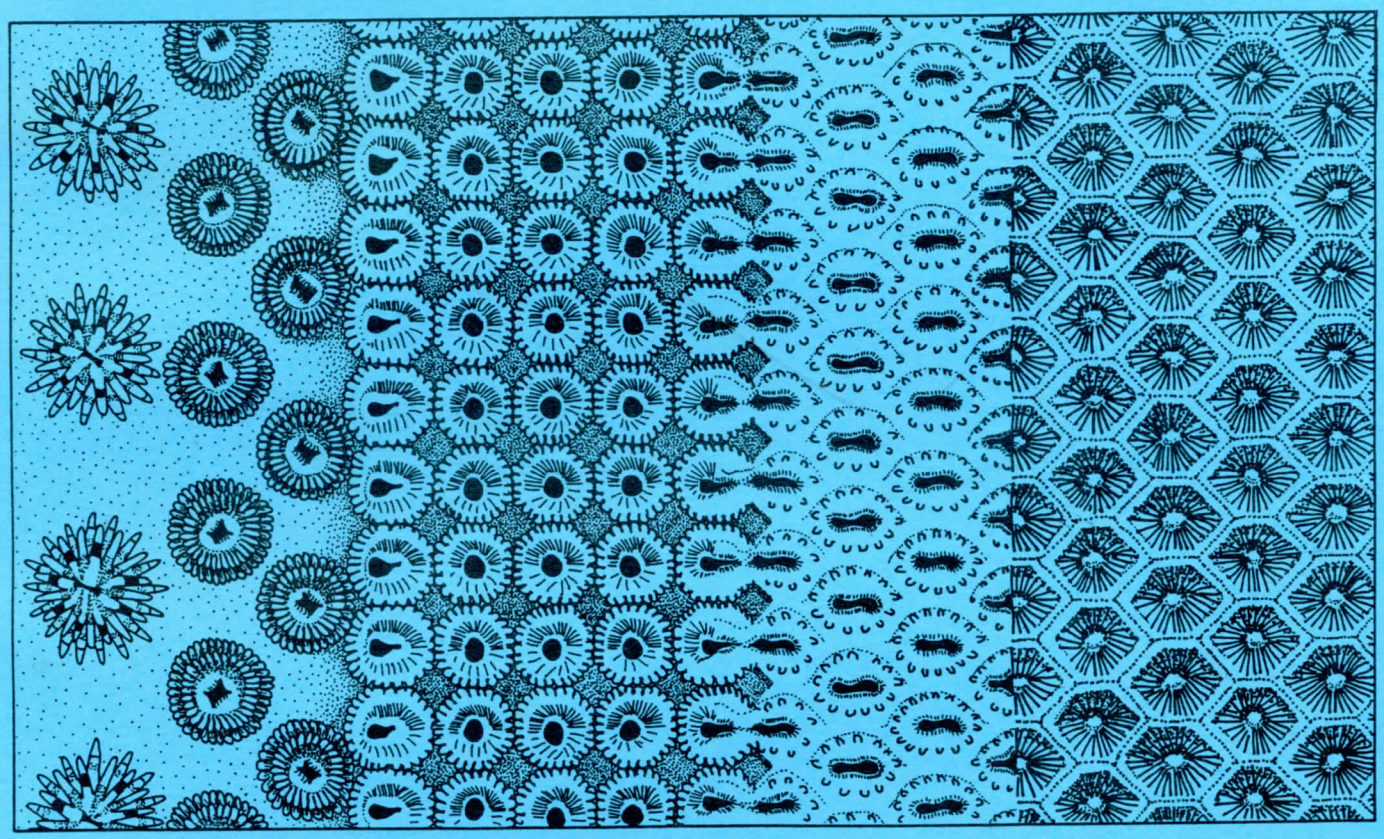
REEF ENCOUNTER

Newsletter of the International Society for Reef Studies

Number 10 December 1991



Drawing by Jeremy Thomason

CHANGING REEFS

Monitoring and More Monitoring!

REEF ENCOUNTER No. 10 December 1991

NEWSLETTER OF THE INTERNATIONAL SOCIETY FOR REEF STUDIES

Edited by Sue Wells and Callum Roberts

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

Its aim under the constitution is to "promote for the benefit of the public, the production and dissemination of scientific knowledge and understanding concerning coral reefs, both living and fossil."

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

i. To hold meetings, symposia, conferences and other gatherings to disseminate this scientific knowledge and understanding of coral reefs, both living and fossil.

ii. To print, publish and sell, lend and distribute any papers, treatise or communications relating to coral reefs, living and fossil, and any Reports of the Proceedings or the Accounts of the Society.

iii To raise funds and invite and receive contributions from any persons whatsoever by way of subscription, donation or otherwise providing that the Society shall not undertake any permanent trading activities in raising funds for its primary objects.

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

Membership

The annual subscription for membership of ISRS is currently US$60 or the equivalent in sterling. Under the constitution, subscriptions are due by January 31st each year. Members receive the journal *Coral Reefs*, the newsletter *Reef Encounter*, abstracts of papers of Annual Meetings and other periodic mailings.

Student, spouse and retired membership costs US$10 or the equivalent in sterling and benefits include all of the above except the journal *Coral Reefs*.

Institutional subscriptions to *Coral Reefs* must be placed directly with Springer-Verlag.

Subscriptions to the Society should be addressed to the Treasurer (address given above).

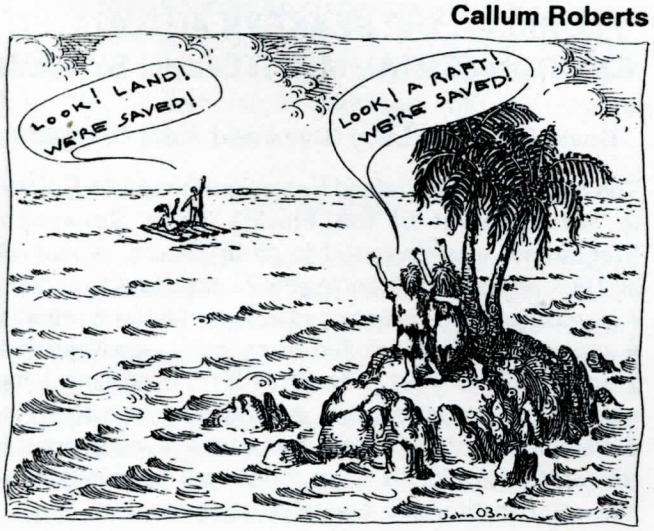
EDITORIAL

Many thanks to all those who contributed information on monitoring projects. We apologise for the heavy cuts we have had to make (and to other articles), but it seemed important to cover as many as possible, if only briefly. This review is of course incomplete, but it gives an idea of the projects underway and methods being developed. Further contributions will be welcome. The report of the Proceedings of the 'Workshop on Coral Bleaching, Coral Reef Ecosystems and Global Change' held in 1991 (see p. 16) stresses the importance of monitoring and includes a general statement of needs and objectives for an institutionally-sponsored, long-term research and monitoring network to assemble directly comparable data sets. Practical recommendations for establishing such a network are outlined in an appendix. Further development of these ideas will take place during a closed December workshop hosted by UNEP-IOC-WMO-IUCN on 'Global Coastal and Near-shore Monitoring Systems' in Monaco in December, and at the International Coral Reef Symposium next year.

Do keep contributions flowing in to *Reef Encounter* and **PLEASE** send material on diskette whenever possible. We have had a recent debate about the use of E-mail and other electronic forms of communication but everyone continues to supply us with contributions as hard copy - your editors spend hours in the old-fashioned activity of copy typing! In fact we admit that for this issue we are indebted to Julie Hawkins for editorial assistance but in future, diskettes would be much appreciated. Thanks to Brian Rosen, D. Jablonski, S. Kidwell, J. Clark and J. Thomason for illustrations.

Finally please note changes of addresses for both editors. Callum Roberts will be based in the U.S. Virgin Islands from January 1992 and we suggest that New World contributors correspond with him. All general enquiries should be addressed to Sue Wells at Newcastle.

Sue Wells
Callum Roberts



Cartoon "borrowed" from the New Yorker, *April 1991*

ISRS COMMENT

From the President:

Peter Sale
e-mail (internet): "P_SALE@UNHH.UNH.EDU"

I was delighted to receive my copy of Reef Encounter No. 9. Sue Wells and Callum Roberts are to be congratulated, but so is the membership. There were more contributions, even some controversies. Let's do even more of this.

There were also the differing views of Bob Buddemeier and Pat Hutchings on our financial status. Believe me Bob, a significant fraction of the Society's postage and travel (what's that?) budget would pay for a bulletin board, but not the e-mail one you have in mind! Pat Hutchings plea for us to pay our dues the first time they are requested is really justified by the fact that we cannot afford the $60 which 180 reminder notices cost to mail! As a thrifty, but necessarily modest move in the direction Bob and Walt Jaap advocate, we should all include our FAX and/or e-mail address when writing to *Reef Encounter*. It's a start.

Our December meeting in Berkeley will have taken place by the time most of you receive this. Some think it's too close to Guam's 7th International Coral Reef Symposium. That's true for people living some distance from either site, but many members are close enough to Berkeley to go there and still get to Guam. And surely we have science to talk about? Certainly, now is the time to think about 1993. The Bermuda Biological Station has offered to host a meeting some time. But there may be other possibilities also - somewhere closer to Europe than Guam, and recognizing that meetings between the quadrennial symposia should be small and regional. They will let some of us get together, while the rest of us make do with e-mail. Ah, the global village.

ISRS NEWS

COMPTES RENDUS DU CONGRES DE L' INTERNATIONAL SOCIETY FOR REEF STUDIES (NOUMEA, 14–18 NOVEMBRE 1990)

Edited by Michel Ricard

Universite Francaise du Pacifique, BP 4635 Papeete, Tahiti, Polynesie Francaise. 1990. ISBN 2-9505597-0-0. Available from the publishers: Fax (689) 41 01 31.

Major themes in the ISRS 1990 annual meeting were environment, management and natural resources in the South Pacific. Texts of papers have been combined with reports on workshop discussions, and the publication is in a double-column, bilingual (French and English) format.

UPWELLINGS

On robustness and fragility

Coral reef communities as a general phenomenon are clearly robust - the survival of taxa and community structures through the Plio-Pleistocene climate and sea level oscillations testifies to that. I think the debate with respect to specific individual reefs bogs down because "fragility" is not a useful concept. Specific reefs and the specific characteristics of communities on them at any given time, are perhaps better regarded as geologically ephemeral rather than fragile - survival of the larger biological system has been provided not by Maginot Line defence of specific pieces of real estate, but by defence in depth (strategies of reproduction, dispersal, colonization, etc.) that facilitate comebacks after setbacks. Whether we are concerned with monitoring or with conservation, it is very important to specify whether we are addressing present-day characteristics of a specific reef, or reef community structure and function on a scale (time, space, or both) that provides a reasonable statistical sample of a variable phenomenon. The issues, approaches, and options are necessarily very different for the two cases, and in the individual reef case we have to address the question of whether our focus is a particular snapshot of a transient system, or the boundary conditions within which processes (natural or otherwise) function.

Bob Buddemeier, Kansas Geological Survey, 1930 Constant Ave., Campus West, Univ. of Kansas, Lawrence, KS 66047, USA. Fax 913-864-5317.

Bulletin boards and *Reef Encounter*

In response to the debate about use of electronic communications in the last Reef Encounter, Walt Jaap writes:

I was misinterpreted on the aspect of using the electronic bulletin board to publish *Reef Encounter*. I meant that just some articles or short versions (electronic abstracts) on important issues be sent. The benefit would be to hook other reef researchers into becoming members of ISRS. I am aware that some folks will find this difficult. Another idea: monthly, I could down-load new information from the bulletin board which could be filtered for use in *Reef Encounter*. Barbara Kojis has suggested putting an index of articles in *Reef Encounter* and *Coral Reefs* on the bulletin board to entice the timid and cheap into jumping on the band wagon!

Walt Jaap, Florida Mar. Res. Inst., Div. Mar. Resources, Fla Dept Nat. Resources, 100 Eighth Ave. S.E., St Petersburg, Fla 33701-5095, USA. Fax: 813-823-0166.

DEADLINE FOR THE NEXT ISSUE OF *REEF ENCOUNTER* IS MAY 1ST 1992.

CURRENTS

MONITORING, AND MORE MONITORING!

"What we need is monitoring, and more monitoring! – on all spatial scales, on all time scales, and with very long-term commitment". Don Kinsey summed up the monitoring issue like this in his contribution to the 'Workshop on Coral Bleaching, Coral Reef Ecosystems and Global Change' held in Miami in June 1991 (see p . 16). Our request for information on projects involving long-term monitoring produced a good response. Projects range from the sophisticated Seakeys Automated Environmental Monitoring System being set up in Florida, to the simple procedures being used in St Lucia that harness the diving community as a labour force. There has been much criticism of the use of amateurs in data collection, but several of these reports (and the article on survey work in Singapore on page 17) show that, given appropriate tasks, volunteers can make valuable contributions and permit the collection of larger data sets and more frequent samples. This is of course not a full survey of everything underway; we are also aware of monitoring work at Curacao (since 1976) and Panama (through the Smithsonian Tropical Research Institute). A report on the monitoring workshop held at the 1990 ISRS Annual Meeting in Noumea, New Caledonia, is now available in the meeting proceedings.

The next step must be greater discussion and exchange of information on the methodology used in different programmes. As mentioned in *PSA Newsletter* 23 (July 1991), John Ogden and Bill Wiebe are proposing a discussion session on 'Regional Monitoring Programmes for Coral Reefs and Associated Systems' at the 7th International Coral Reef Symposium in Guam in 1992. This would permit exchange of information about existing and proposed monitoring programmes and initiate a global network and co-ordinating strategy.

FLORIDA – THE SEAKEYS AUTOMATED ENVIRONMENTAL MONITORING SYSTEM

David Forcucci, Lucy Given and John C. Ogden

The SEAKEYS (Sustained Ecological Research Related to Management of the Florida Keys Seascape) Programme was designed to study natural processes and human impact influencing the Florida Keys seascape. A key component is automated environmental monitoring equipment that was installed along the Florida Keys Reef Tract in 1989 to 1991. The SEAKEYS Programme has established an interactive database to assist in the development of research and management policies related to the Florida Keys which will be available to interested institutions, agencies and groups.

Four stations (Fowey Rocks off Miami, Molasses Reef off Key Largo, Sombrero Reef off Marathon, and Sand Key off Key West) have been set up. Additional stations, funded by Florida Department of Natural Resources (DNR) will be installed in the near future in Florida Bay north of Long Key and at Dry Tortugas.

Wind speed, direction and peak gust, precipitation, barometric pressure, air temperature, solar irradiance above water, near surface and at 3m depth, seawater temperature near surface and at 3m depth, and near surface salinity are monitored at each station. Existing lighthouse structures were used as station platforms for ease of accessibility and permanence. The stations are modified versions of the standard NOAA Coastal Marine Automated Network (C–MAN) meteorological monitoring stations set up at Molasses and Sombrero. The NOAA National Data Buoy Center (NDBC) revised this to include measurement of oceanographic parameters.

A Hydrolab Scout monitors water temperature and salinity, storing data internally in memory. FIO personnel at the Keys Marine Laboratory (KML) exchange the Scouts at all stations with newly calibrated instruments every 6 weeks.

LICOR Quantum sensors measure photosynthetically active radiation (PAR) above water and underwater. Both these and the SCOUT are cleaned biweekly. Agencies assisting with cleaning and providing logistic support include Biscayne National Park at Homestead, NOAA National Undersea Research Center at Key Largo, and Reef Relief of Key West. FIO personnel at the KML maintain the Sombrero Reef Station.

Data Collection

Data are transmitted hourly from each station to the Eastern Geostationary Operating Environmental Satellite and relayed to the NOAA data receiving station at Wallops Island, Virginia (Figure 1). These are immediately available via landline. Personnel at the KML have access to this system instantaneously and check the data daily for accuracy and possible problems. FIO has established a cooperative agreement with NDBC to verify and archive all data collected at the Keys stations, which are received two months after collection. A database has been established at the KML which contains initially the real-time data, subsequently replaced with the quality-controlled archived data.

Data Analysis

Studies of water quality, reefs and water transport are some of the many uses for the data produced by the C–MAN stations. The Florida Keys National Marine Sanctuary (FKNMS) was established in 1989 with water quality a primary concern. The C–MAN stations encompass the geographic range of the sanctuary and will provide critical data for its management on a daily basis.

Researchers will also be able to monitor the effects of water currents on the coral reef tract. Channels through the Keys allow Gulf of Mexico and Florida Bay water to move out to the reef. The reef tract is influenced by these water masses at low temperature in winter and high temperature in summer. For example, C–MAN stations will allow a winter cold front with associated cold water masses to be followed in real time. Severe temperature changes associated with Florida Bay water are acknowledged to be a major influence on the Keys coral reef tract. The study of water transport, using the records of the C–MAN stations, will show general water circulation patterns and salinity fluctuations, and suggest possible nutrient transport from the Keys to the reef.

The Florida Current flows north adjacent to the reef tract and monitoring stations, often flowing over the reef. Stations at Fowey Rocks and Molasses Reef may prove to be more frequently subjected to water from the Florida Current since it passes closer to them. Periodic upwellings deliver cold, nutrient-rich water to the reef tract and may exert a major, though undocumented, influence.

Long-term recording of water temperatures by the C–MAN stations will show yearly fluctuations and long-term changes potentially associated with global climate change. Local variations along the reef will also be recorded. Figure 2 shows that water temperatures vary remarkably even within a distance of 50 miles. The mean water temperatures at Sombrero Reef were more extreme than at Molasses Reef. This suggests that Sombrero Reef and adjacent reefs are influenced more by Gulf of Mexico and Florida Bay water than Molasses Reef.

The impact of severe tropical weather will also be monitored by the stations. This long-term collection of data by C–MAN stations will provide a dependable, accurate information source for researchers, area managers, and future generations.

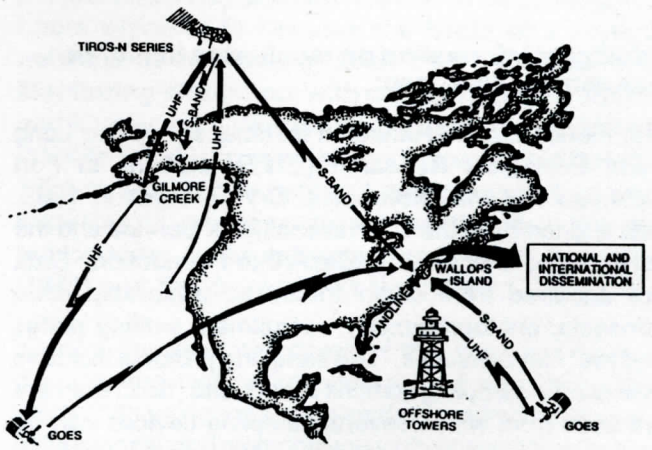


Figure 1: Transmission of C–MAN data

experimental design, instrumentation, data analysis and storage. Technical panels would also act as review bodies for specific monitoring projects.

Once the goals and priorities for long-term monitoring have been established and methodological problems resolved, the next step will be to decide on and implement specific tasks. Monitoring the entire reef is a mammoth task and is presently beyond the capabilities of any single organisation. It is expected that different aspects of the programme will be carried out by a number of organisations and consultants and that GBRMPA will play a coordinating role in acquisition, storage, interpretation and dissemination of data. Although it is early days yet, we are optimistic that we have laid the groundwork for what will become a major programme within GBRMPA, and which will provide vital information for managing the reef for decades to come.

Jamie Oliver, GBRMPA, Townsville, Qld 4811, Australia. Fax: (61) 77 726093.

HAWAII – SCIENTISTS AND VOLUNTEERS TO JOIN FORCES

As in numerous countries, many nearshore reefs in the Hawaiian Islands are reported to have undergone substantial degradation over the past few years. However, most reports are subjective and anecdotal. A legislative appropriation this year recognised the need to obtain long-term monitoring data and a programme is being developed to establish three permanent monitoring sites in Hawaii (Hanauma Bay, Oahu; Honolua Bay, Maui; and Puako, Hawaii). All three sites are protected as Marine Life Conservation Districts or Fishery Management Areas. Hanauma Bay is impacted by heavy use (5,000–7,000 tourists/day with three septic drain fields; toilets back up at extreme high tides). Honolua Bay is subject to heavy sedimentation loads and agricultural runoff. Puako is the most pristine reef system, but has considerable groundwater input and drainage from nearby residential cesspools.

Three 10m transects have been marked and tagged within six to ten areas at various depths or exposures at each of three sites. Each site will be censused quarterly using a combination of line intercept, chain transect, and videographic methods. Proposed expansion of this effort will allow the inclusion of additional sites and the training of amateur divers (recreational dive clubs, undergraduate students) who will be used to assist in monitoring (deploying transect lines, swimming video transects, collecting samples for water quality analysis).

Diseased (bleached and/or necrotic) patches have been noted on corals at all three sites, particularly *Porites lobata* and *P. compressa* at depths of 3–5m. Turf algae invade the necrotic areas within a few days. Patches of dead/dying coral have increased in size and frequency at the Hanauma Bay site over the past 12 months from hand sized patches on 5–10% of colonies to up to 1m² areas on >90% of colonies in some areas). The progress and pathology of this disease will be followed through macro-

THE COMPLEAT REEF ENCOUNTER No. 10

"Their distribution is not limited to tropical waters. Reefs may be found off British coasts, the Mediterranean Sea, the Norwegian waters and even in areas where there are great depths of water, although they do tend to flourish in regions with tropical temperatures and intense sunlight."

From: 'Coral reefs - a vanishing world'. *ANIMALS International* X/34. 1990. (Official publication of the World Society for the Protection of Animals).

photographic and histological examination of cored tissues.

The long-term goal of these monitoring efforts is to investigate the temporal and spatial dynamics of coral-algal community structure. The relative 'health' of the populations will be assessed through comparisons of net changes in living coral tissue cover through time.

Cynthia Hunter, University of Hawaii, Hawaii Inst. Mar. Biol., P.O. Box 1346, Kaneohe, Hawaii 96744, USA. Fax: (808) 2367401.
Mark Stephenson, Moss Landing Marine Labs, P.O. Box 450, Moss Landing, CA, 95039, USA.

ST LUCIA — AMATEUR DIVERS PROVIDE THE LABOUR

Allan Smith, at CANARI (Caribbean Natural Resources Institute) sent information on the coral reef monitoring project underway at Soufriere on the west coast of St Lucia which is to become the basis of a regional network of monitoring activities. A Coral Reef Monitoring Workshop, with support from the John D. and Catherine T. MacArthur Foundation and World Wildlife Fund–US, was held in St Lucia, 3–4 October 1991 to set up the network and provide first hand experience of appropriate methods. We are reproducing some extracts from Geoghegan *et al.* (1991) and Smith and Van't Hof (1991):

"One of the main objectives of this work has been to develop and test approaches to reef monitoring that, rather than trying to fit inappropriate methods to an area, build a monitoring protocol around the available resources and expertise while still obtaining relevant and useful data. The experience has shown there are at least two main reasons for the limited amount of reef monitoring in the region. The first is a failure to involve the communities of resource users, and the second is the promotion of methods that could only be applied by experts and which are not specifically designed for monitoring."

"The effectiveness of a monitoring programme depends on repeated use of appropriate methods for

data collection. Dive leaders spend more time in the water than any other group, and have a level of expertise that enables them to collect a large amount of information while carrying out normal daily activities, given the right methods. However, their potential contribution to monitoring programmes has largely been ignored. This is significant since much of the effective management of the recreational use of reefs is presently being carried out by dive leaders. It is they who control the activities of most divers, particularly by reducing accidental damage to the reef. The Soufriere monitoring programme therefore involved dive operators in planning, site selection, construction and installation of equipment, and the continuing collection of samples and data.

In the past, much of what has been labelled as monitoring methodology has been copied with little or no change from methods originally designed for studies of species interactions, succession, diversity, population dynamics and productivity. Experience has shown that the methods demand far more time, resources and expertise than are available for a monitoring programme. Essentially, technical staff do not have the time, or inclination, to spend measuring and identifying reef species underwater, and the methods cannot be used by anyone else.

In the present case, methods were designed to allow dive operators to contribute to national or regional programmes to monitor changes in reef structure and the levels of certain impacts. Increasing sediment load is commonly implicated in reef degradation, and sedimentation rates are being determined by installing sediment traps on a number of reefs. Traps placed at recognised dive sites can be replaced by dive leaders in minutes. Increasing diving activity is also a cause of reef degradation, and managers of the dive operations also record the numbers of dives made at all sites.

Monitoring changes in reef community structure is more complex, but can be greatly simplified using photography. This has the advantage that expertise in identifying species is only needed at the outset, when a permanent station is established. With a suitable frame for mounting the camera, any competent diver can rephotograph the permanent quadrats and the photographs can be analysed elsewhere."

REFERENCES

Geoghegan, T., Renard, Y. and Smith, A. 1991. Community participation in protected area management: some cases from the Caribbean. Regional Symposium on Public and Private Cooperation on National Park Development, Tortola, BVI, August.

Smith, A. and van't Hof, T. 1991. Coral reef monitoring for management of marine parks: cases from the insular Caribbean. In press.

CARICOMP

The Caribbean Coastal Marine Productivity (CARICOMP) program was established in 1985 as part of the COMAR (Coastal Marine) Program of Unesco and is directed at the long-term monitoring of coral reefs, seagrasses and mangroves in the Caribbean (see *PSA Newsletter* 23, July 1991). The monitoring will be carried out simultaneously at laboratories throughout the region using standardised methods which have been described in the manual *'Level 1 Ecosystem Monitoring Methods Manual'* (available in English and Spanish). The data will be analysed centrally at the Data Management Center of the University of the West Indies in Kingston, Jamaica and freely distributed. Over 20 laboratories and institutions (Venezuela (4), Curacao (1), Colombia (1), Panama (1), Belize (2), Nicaragua (1), Honduras (1), Mexico (3), Cuba (2), Jamaica (1), Caymans (1), Dominican Republic (1), USA (Puerto Rico (2), US Virgin Islands, Florida), Netherlands Antilles (1), Guadeloupe (1), St Lucia (1), Trinidad and Tobago (1), Barbados (1), Suriname (1), Bermuda (1), Bahamas (1)) have expressed interest to date.

Further information from: *Dr E. Jordan Dahlgren, Univ. Autonoma de Mexico, Apartado Postal 1152, Cancun 77500, Mexico; Dr J. Ogden, Florida Institute of Oceanography, 830 First St South, St Petersburg FL 33701, USA; Dr W.J. Wiebe, Dept Microbiology, Univ. Georgia, Athens GA 30602, USA.*

US NATIONAL PARK SERVICE CORAL REEF ASSESSMENT PROGRAMME

Caroline Rogers sent the following information on monitoring in the USA and eastern Caribbean:

In 1988, the US National Park Service provided $590,000 to support a coral reef assessment programme for 5 years in cooperation with six institutions. The goal is to establish effective long-term research and monitoring programmes at the four National Park Service units which have coral reef ecosystems: Virgin Is. National Park, Buck Is. Reef National Monument, Fort Jefferson National Monument and Biscayne National Park.

At the beginning of the programme, about 25 scientists and managers met to discuss and outline the components of an effective monitoring programme. A summary of the recommendations appears in Rogers (1988).

In addition to establishment of monitoring sites, the objectives are to (1) develop and evaluate standardised methods for assessment of trends on coral reefs, (2) provide baseline data on reef fish and coral populations and environmental parameters, and (3) determine natural rates of change. Major accomplishments to date include quantification of the effects of Hurricane Hugo on reefs at Buck Island and the Virgin Islands National Park and rates of recovery from the storm; interpretation of the geological history of Buck Island Reef; evaluation of photographic and other methods; and assessment of natural rates of change in living coral cover at all sites. A great deal of effort has gone into establishing permanent transects and photostations at the four sites, monitoring of individual coral colonies, censusing of fish populations, installation of recording thermographs, and evaluation and fine-tuning of methods.

We are using a variety of photographic techniques as well as quadrat and linear transect methods. Our recommendations will be summarised in a coral reef monitoring manual, and a synthesis of the work to be prepared will include comparisons between Florida and USVI reefs. Some of the research will be published soon in *Coral Reefs* and in *Marine Ecology Progress Series*, and additional findings reported at the 7th Int. Coral Reef Symposium in Guam.

REFERENCE

Rogers, C.S. 1988. Recommendations for long-term assessment of coral reefs: US National Park Service initiates regional program. *Proc. 6th Int. Coral Reef Symposium* 2: 399-403.

Caroline Rogers, National Park Service, Virgin Is. National Park, 10, Estate Nazareth, St Thomas, USVI 00802. Fax: 809-776-4714.

JAMAICA

Terry Hughes sent a brief outline of his ongoing monitoring of reefs close to the Discovery Bay Marine Laboratory. The primary objectives are to describe long-term dynamics of corals (recruitment, growth, mortality) and coral assemblages (changes in cover, relative abundance and diversity).

He established replicate permanent sites in 1977 which have been monitored annually using a variety of photographic, quadrat and line transect techniques. He has also followed algal biomass and benthic herbivore abundances, and conducted a range of short-term experiments. During the 14 year course of the study, Jamaican reefs have been subjected to two major hurricanes, a protracted algal bloom following mass-mortalities of *Diadema antillarum*, and several bouts of bleaching. Overfishing and sediment runoff have also increased at some sites. Coral cover on most fore-reef sites has declined from 60–80% in 1977, to <5% in 1990.

Funding for this project has come from short-term grants (up to 3 years), mainly from the US National Science Foundation, the National Geographic Society, and the Whitehall Foundation. The results have so far been published in 10 papers (see Hughes 1989, and references therein).

REFERENCE

Hughes, T.P. 1989. Community structure and diversity of coral reefs: the role of history. *Ecology* 70: 275-79.

ASEAN–AUSTRALIA CO-OPERATIVE PROJECT
Living Resources in Coastal Areas

Reef scientists from Indonesia, Singapore, Malaysia, Thailand, Philippines and Australia have agreed on a standard method for surveying and monitoring in the ASEAN region. It is semi-quantitative, requires a minimum of taxonomic knowledge and yields data that are amenable to ecological analyses of coral reef assemblages. The package of methods runs from the transect work in the field to data analysis, and are described in: Dartnall, A.J. and Jones, M. (1986). *Manual of Survey Methods*. Australian Institute for Marine Science. The manual was revised at a workshop held as part of the project in September 1990 on 'Coral Taxonomy and Life Forms'. The workshop was also designed to provide training on field identification and set criteria for methodologies (line transect and fixed photos).

Further information from: *Helen Yap, Marine Science Institute, University of the Philippines, P.O. Box 1, Diliman, Quezon City 1101, Philippines.*

INDONESIA, THAILAND AND MALDIVES

The University of Newcastle-upon-Tyne in the UK, in collaboration with the Centre for Oceanological Research and Development, Jakarta, Indonesia, has been monitoring coral reef communities at Pulau Pari, Thousand Islands, since 1979. They have also, with the Phuket Marine Biological Centre (PMBC), been monitoring reef flats of Phuket (1979–present), and in the Maldives, with the Marine Research Section, have recently established a reef rehabilitation programme involving monitoring (1989–1993+). Thai and Indonesian studies have focused on the use of permanent, regularly monitored line transects; data being supplemented in Thailand with photographic records of belt transects from 1979 onwards. In addition, a number of environmental parameters (water temperature, salinity, turbidity, primary productivity, nutrients) have been recorded monthly at three different depths adjacent to the PMBC for the last ten years. Data from these 12 year studies in Thailand and Indonesia have enabled us to assess the responses of reefs to increased seawater temperature and dredging (see references).

Regular monitoring of mined and unmined Maldivian coral reefs is being funded by the UK Overseas Development Administration. An environmental data logger measuring water temperature, salinity, current velocity and wave height has been in place there since early 1991. Monitoring is ongoing at these locations and likely to be expanded in the period 1992 to 1995.

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Warwick, R.M. *et al.* 1990. A statistical analysis of coral community responses to the 1982-83 El Nino in the Thousand Islands, Indonesia. *Coral Reefs* 8, 171-79.

Brown, B.E. *et al.* 1990. Evaluation of the environmental impact of dredging on intertidal coral reefs at Ko Phuket, Thailand, using ecological and physiological parameters. *Mar. Ecol. Prog. Ser.* 65, 273-81.

Further information and addresses of collaborating institutions from: *Barbara Brown, Centre for Tropical Coastal Management Studies, Dept of Marine Sciences and Coastal Management, The University, Newcastle, NE1 7RU, UK.*

REEFWATCH

Reefwatch is a programme run from the Tropical Marine Research Unit at the University of York, UK, which seeks to involve amateur divers in collection of descriptive and monitoring data in coral reef areas. Established in the early 1980s, the programme pioneered an area which is now receiving increasing interest (see for example projects in Hawaii and St Lucia). Reefwatch uses a combination of standard quantitative methods (transect and quadrat counts of fish and invertebrates) combined with semi-quantitative and qualitative estimates of reef diversity, human use and impacts. Methods have been thoroughly tested in the Red Sea and Caribbean where much of the data collection has so far been concentrated. Publications resulting from Reefwatch studies include Roberts *et al.* (1988, in press). The system has been designed to be modular, allowing tailoring to specific needs of a wide variety of projects, and perhaps for this reason has proven very popular with UK university expeditions. The scope of the programme is intended to be global but further development is dependent on additional funding.

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Roberts, C.M., R.F.G. Ormond & A.R. Dawson Shepherd 1988. The usefulness of butterflyfishes as environmental indicators on coral reefs. *Proc 6th Int Coral Reef Symp.* 2: 331-36.

Roberts, C.M., A.R. Dawson Shepherd & R.F.G. Ormond. In press. Large scale variation in assemblage structure of Red Sea butterflyfishes and angelfishes. *J. Biogeog.*

Further details from: *Rupert Ormond or Lynne Barratt, TMRU, Dept of Biology, Univ. of York, York, YO1 5DD, UK.*

FRENCH POLYNESIA

Monitoring has been underway for a few years at several sites around Tahiti and Moorea. Further details from:

Bernard Salvat, Centre de Biologie et d'Ecologie Tropicale et Mediterraneenne, Universite de Perpignan, Av. de Villeneuve, 66025 Perpignan CEDEX, France. (see also papers by Aubanel, Caries and Salvat in: Ricard, M. (Ed) (1991). Comptes Rendus du Congres de l'International Society for Reef Studies (Noumea, 14–18 novembre 1990), Universite Française du Pacifique).

OTHER PROGRAMMES UNDER DEVELOPMENT

PACICOMP

This program was proposed at the 1991 Pacific Science Association Congress in Honolulu and would be based on a similar system to CARICOMP but covering the Pacific.

Further details from: *Chuck Birkeland, Marine Laboratory, University of Guam, UOG Station, Mangilao, Guam 96923.*

WORLD CORAL REEF SITE NETWORK

A network of laboratories carrying out detailed monitoring of a selected few reefs was also proposed at the 1991 Pacific Science Congress. This would be complementary to CARICOMP and PACICOMP, which focus on collecting data in a simple manner over a large geographic area, in that it would place the emphasis on more detailed studies of reefs.

Further details from: *Bernard Salvat (address above).*

DOMINICAN REPUBLIC

WWF–US is developing a project to survey reefs at three marine park sites in the Dominican Republic using volunteers (Parque del Este in the south-east; La Galeta near Santa Domingo; and Monte Cristi on the north coast). The *Coral Reef Monitoring Handbook* prepared in 1981 by Dahl for the South Pacific is to be modified for use in the Caribbean and will be translated into Spanish and French. The project is in collaboration with the Department of Natural Resources in Puerto Rico. A workshop will be held to train survey participants in the necessary techniques, and the survey will take place over one year, supervised by CIBIMA. It is planned that the reefs should be surveyed in later years by park managers using the same techniques, and perhaps involving the same volunteers. Information from the first survey will be used to prepare baseline maps for the management plans for the three parks.

Further information from: *Evelyn Wilcox, Latin America and Caribbean Program, WWF–US, 1250 Twenty Fourth St NW, Washington D.C. 20037, USA. Fax (202) 2939211.*

"I don't know why I don't care about the bottom of the ocean, but I don't."

FEATURES

DO's AND DON'Ts FOR SETTING UP MARINE PARKS

Tom van't Hof

Estimates of the number of protected areas that include coral reefs or coral habitats worldwide range from 185 to 220 (UNEP/IUCN, 1988; WCMC/IUCN, 1991).

Survey work on the effectiveness of marine protected areas in general (*not just coral reef protected areas*) in the Wider Caribbean has revealed that roughly 75% are not really protected because of lack of management (OAS/NPS, 1988; van't Hof, 1988). If such a large percentage of protected areas are not accomplishing their goals, we need to ask ourselves what we are doing wrong. At least part of the answer lies in the way we are setting up marine protected areas.

We can distinguish two approaches to setting up (marine) protected areas:

1. A systematic approach, whereby protected areas are declared on the basis of a protected area systems plan.

2. An *ad hoc* approach, whereby protected areas are declared in response to serious habitat degradation, or threats to species or ecosystems.

The first approach is of course the best (or should I say the only correct one) because it is based on research and consultation. It also offers better prospects for integrating the conservation of all coastal (both terrestrial and marine) systems and processes which are intimately linked. It would undoubtedly be the preferred approach if it were accompanied by adequate funding to *develop and manage* the system of protected areas. In this respect, however it often fails or is too tardy, especially in developing countries.

A further disadvantage of the systematic approach is that it is time-consuming, requires complicated multilevel political decisions and, as a result, is unresponsive to situations requiring immediate action. Systems plans in preparation have even hampered the establishment of protected areas which have received local support and the interest of the donor community.

The second approach will clearly be more responsive to urgency, will usually enjoy greater public interest and support, and hence have a better chance of political support, and more rapid funding by government as well as non-government sources. Thus in planning and developing marine protected areas one should follow the systematic approach when time is not a limiting factor. On the other hand, when time is running out (and this is probably the rule rather than exception), one should quickly mobilize resources, and act.

How do you do it in practice?

This article is not meant to instruct the reader in the preparation of a marine park protected area systems plan. Rather, in the following section of DO's and DON'Ts, I want to address the situation where time is running out, where you as an individual see the necessity to develop a marine park and to act quickly, but where you are struggling with the question how.

DO gather all ***available*** information on the distribution of resources and habitats and prepare rough maps.

DO NOT postpone decisions until all the data and information you would like to have have been collected. Collect only what is absolutely essential to determine the size and boundaries of the area and incorporate further data collection into the programme to develop and manage the marine park.

DO gather all ***available*** information on present and potential uses, impacts and threats which affect the resources (e.g. fishing, collecting, mining, shipping, recreation, sewage disposal). Map this information. Your maps will demonstrate which areas are most heavily affected and where conflicts of interests may occur.

DO aim for as large an area as possible and zone it to allow for different uses (a zoning plan can be prepared on the basis of the mapped uses, impacts and threats). This reflects an integrated approach to coastal resources management allowing control over a relatively large area rather than just the establishment of a marine park, which is often looked upon as highly restrictive. It has also a psychological advantage: a large area with only certain zones being subjected to a strict control regime may be easier to "sell" than one smaller area but with severe restrictions on resource use.

DO NOT delay implementation unnecessarily by creating another committee, by commissioning another study, or referring the proposal to yet another department for review.

DO lobby to enlist political support.

DO use economic analyses of the proposed protected area to help convince politicians and decision makers. Most coral reef protected areas are very important in relation to tourism and their economic benefits from tourism are easily demonstrated.

DO act quickly when the timing is politically opportune. Your support may have vanished after elections!

DO prepare a basic project plan for the establishment of the protected area, but **DO NOT** spend too much time on an elaborate management plan (decision makers don't read long documents and once the area has been

established a "management handbook" will be much more useful).

DO involve the public in general and the resource users in particular in the planning and design of the protected area. Introduce proposed new legislation at public hearings and be prepared to compromise on controversial issues. Involve the users in resource assessments. **DO NOT**, for example, underestimate the knowledge of local fishermen.

DO actively seek NGO involvement in the establishment and management of marine protected areas. Governments of countries that have a park service or similar Government department are unlikely to delegate responsibility for park management to an NGO, but other Governments may. In some instances the possibility to delegate is already incorporated into the basic conservation legislation. The main advantages of NGO involvement are their far less bureaucratic structure and ability to raise funding. This can be especially important in the start-up phase when substantial funding may be required and NGO's can tap into a much wider range of aid agencies than Governments.

DO attempt to make your marine protected area self-financing as much as possible. Revenue can be generated through visitor/user fees, concession fees, conservation levy, souvenir sales, donations, memberships and sponsoring. Use volunteer assistance whenever feasible and practical.

If resource users such as fishermen are seriously disadvantaged by the creation of a marine park, **DO** try to build in compensation for these users into the project budget.

Some final "words of wisdom": **DO** try to be modest in your project design, be creative and flexible and be prepared to put in a lot of hard work and dedication. Remember: you're out there on your own and if you want to get things done you will have to do them yourself.

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Tom van't Hof, Marine & Coastal Resource Management, The Bottom, Saba, Netherlands Antilles. Fax: 599-4-63299.

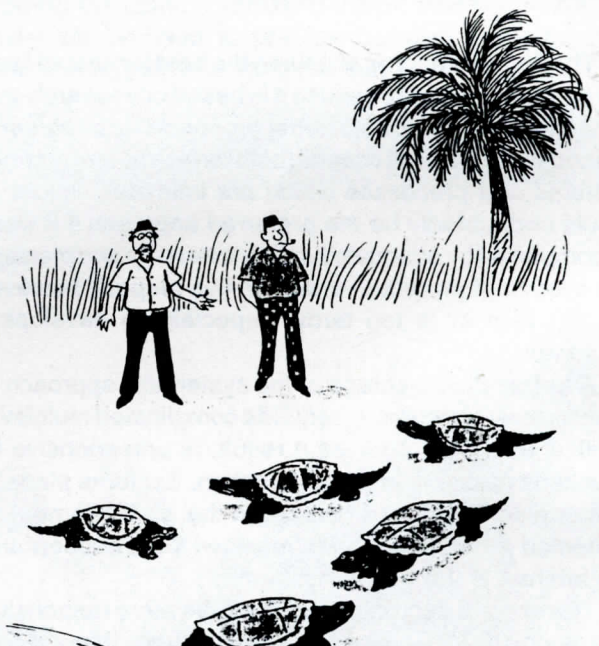
CORAL REEFS AND REGIONAL CLIMATE IN SINAI

Ramy Klein

In 1987, with Prof. Yossi Loya, I started to study the growth patterns of *Porites* from the Gulf of Aqaba, Red Sea. Although coral reefs of the Gulf of Aqaba have been extensively studied and described, little was known about growth patterns of massive corals or their banding phenomena. Unlike the banding in Great Barrier Reef corals (Isdale 1984), we found that low density (LD) bands in Red Sea corals are deposited during summer and high density bands (HD) during winter (Klein 1989). Bands were tested under U-V light for fluorescence. Isdale (1984) had shown that annual banding of fluorescent sequences in living scleractinian corals can be used to study terrestrial runoff in the nearshore environment. Fulvic and humic acids from degraded plant material, carried into the sea by rainwater, were incorporated into the skeleton and fluoresce under UV light. The lack of terrestrial run-off and the rare occurrences of river discharge in the arid environment surrounding the Red Sea resulted in no such phenomenon being found.

The idea that fossil corals from Sinai could tell us something about past climate arose while climbing the

Punch, October 1984



"After the females lay their eggs, biologists convey them to a safe place. Both turtles and biologists benefit, a classic example of symbiosis."

elevated reefs around Sharm-el-Sheikh. A well preserved belt of three elevated fossil terraces, up to 35m above mean sea level, stretches along the coast of Southern Sinai. These were formed during periods of late Quaternary high-stand sea levels. The Upper Terrace is older than 250 Ka, the Middle 140-200 Ka, the Lower 108-140 Ka and the modern fringing reef is 10,000 Ka and younger.

On my return to Tel-Aviv I examined *Porites* from the fossil collection for growth patterns and fluorescence. It was astonishing to discover yellow-green fluorescence sequences along the fossil slice, similar to those found in GBR corals. A second field trip to Sinai with Prof. G. Gvirtzman from the Geological Survey of Israel was conducted, in order to obtain further geological information on the area. At AIMS, using HPLC (High Pressure Liquid Chromatography), we found that fluorescence in Sinai fossils was due to humic acid incorporated into the skeleton. Fluorescent sequences were superimposed on low density sub-bands. Assuming unchanged seasonal deposition of bands from the modern pattern (LD in summer and HD in winter), fluorescent bands in the fossil corals correspond to summer events.

We attributed the terrestrially derived humic compounds in the fossil corals from Sinai to the late Quaternary runoffs. These findings indicated that during the time of reef growth and high-stand sea levels, a wet climate, possibly with a summer rainfall regime, probably prevailed in the Sinai. This is in marked contrast to the present extreme desert conditions (with rare rainfall in winter). Summer rainfall in the Sinai during the late Quaternary provides possible evidence of northward extension of the monsoon belt over the Sinai region (for further details see Klein et al. 1990), which currently only just touches the far southern Red Sea.

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My latest trip to Sharm-el-Sheikh was in January 1990. Standing on the edge of the reef terrace the fossil gallery was still evident, even though mass construction of hotels was underway. A glance at the field school atop the terrace was a reminder of the long period of Israeli activity in the region. In the last few years the field school has been used as a research centre and marine science department. During my stay I enjoyed the hospitality of Callum Roberts who had become almost the "Bedouin chief of the place" and his Egyptian colleagues. I was deeply concerned by what I heard about construction plans in the area, especially the removal of the marine research centre (see *Reef Encounter* 9 p11), and hope that greater attention and care will be given to such places in future management of the region.

Ramy Klein, Zoology Dept., Tel-Aviv Univ., Ramat-Aviv 69978, Israel.

OPTIMISATION OF CORAL REEF FISHERIES – A PILOT PROJECT

Gudrun Gaudian & Paul Medley

Coral reefs form the basis of many small scale subsistence fisheries throughout the tropics, and the aim of coral reef fisheries management is often to increase the sustainable yield.

In an experimental project to develop assessment techniques, we monitored changes before and after fishing on fringing reefs around Zanzibar (Tanzania). Local fishermen were employed to intensively fish a restricted area over a given period of time. Fish abundances inside and around the fishing area were estimated by transect counts. Detailed information was collected on catches, including species, length and weight.

Preliminary analysis of the data (Gaudian & Medley, in prep) concentrated on two species, *Lethrinus borbonicus*, which made up 50% of the catch, and *Chaetodon kleinii*, which was very rarely caught. As fishing progressed, there was a notable decline in catch per unit effort (CPUE) mainly caused by falling numbers of *L. borbonicus* in the catch. There was also a distinct change in catch species composition, because *L. borbonicus* declined faster than other species.

We also found large differences in the abundance of fish at different sites within the study area. Numbers of *L. borbonicus* were lower after fishing both inside and outside the fishing area. In contrast, *C. kleinii* showed no significant decline.

An important use of data from this kind of experiment is to estimate gear selectivity. This information is necessary for correct interpretation of catch data, especially where species composition might be useful in describing the state of the fishery.

CPUE, at best, is a relative index of abundance in a fished area. To relate that to stock size requires a model of fish distribution and movement. Such a model is a requirement for setting up effective reserves for fishery management. Our proposed model was developed on the basis of simplicity rather than biological theory. We suggest that fish would redistribute themselves so that all areas would reflect the decrease in population size equally. If this is correct, CPUE data from one site would provide a suitable index for the stock size. Visual census data from outside the fishing area were used to help evaluate this assumption. The model fitted the data reasonably well although there was some indication that the behaviour of the system was more complicated. Simulations and controlled experiments will be used to further test this model.

In this study it was demonstrated that data from such experiments have an important role in developing new fisheries assessment techniques. However there is a clear need for development of theoretical models and statistical methods to deal with these data.

We would be very interested to learn of similar manipulative coral reef fisheries experiments, in particular

NEWS

CORAL REEF INPUT INTO UNCED

The president of ISRS agreed that as a society we should support this draft statement drawn up by the Global Coral Reef Alliance (see p. 19) and circulated to the Working Groups on Oceans and on Biodiversity, at the August 1991 PrepCom meeting (i.e. preparatory meeting) for the UN Conference on Environment and Development which will take place in Brazil in 1992.

"Coral reef ecosystems require special attention within the scope of global efforts to protect our natural resource heritage because of their crucial nature and increasingly degraded status. For this reason the undersigned urge that the following points be specifically incorporated into the Earth Charter, Agenda 21, the UNCED preparatory process, as well as in the Global Climate Change and Biodiversity Conventions:

1. Recognizing that coral reefs play vital roles in maintaining marine biodiversity, in global biogeochemical cycles, and in the economics of tropical marine countries;

2. Taking into account the steady deterioration of coral reef ecosystems worldwide due to human activities including overfishing, dynamiting, dredging, extraction for use as construction material, sedimentation caused by deforestation and erosion, seaweed overgrowth of corals due to sewage nutrient discharges, land-based pollution, marine-based pollution, and other marine ecological disturbances;

3. Noting with alarm the mass bleaching events which have devastated coral reefs around the world in the 1980s following exceptionally high ocean temperatures, and noting that reefs in the Atlantic and Indo-Pacific regions have already begun to suffer extensive bleaching mortality in 1991;

4. Considering that coral reef ecosystems may be unable to tolerate any further stresses, including global warming, without imperiling tropical fisheries, tourism, shoreline protection, and the reef's ability to keep up with sea level rise;

5. We therefore call on UNCED, the global climate convention, and the global biodiversity convention negotiators to address the particularly threatened status of coral reef ecosystems by mandating urgent action to halt destructive utilization of reefs; to abate land-based sources of pollution; to provide appropriate sewage treatment; to reforest watersheds; to protect fishery stocks from overexploitation; to reduce greenhouse gas concentrations in the atmosphere; and to fund long term monitoring of environmental and biological changes in reefs, research on coral reef degradation, efforts to protect coral reef fishery nursery grounds, and other critical habitat, mariculture, reef restoration, and other forms of environmentally-sound coral reef management."

In addition to ISRS, this statement is supported by the following non-government organizations: Global Coral Reef Alliance, Environmental Solutions International, Consortium for Action to Protect the Earth 92 (Environmental Defense Fund, Friends of the Earth, Audubon Society, National Wildlife Federation, Natural Resources Defence Council, Sierra Club), Wildlife Conservation International, Reef Relief, CEDAM (Conservation, Education, Diving, Archaeology, and Museums), International Centre for Marine Conservation, World Wildlife Fund, Project Reef-Keeper, Association of Marine Laboratories of the Caribbean, Pacific Science Association.

COASTAL ZONE MANAGEMENT IN PAPUA NEW GUINEA

For the last twelve months Papua New Guinea's Department of Environment and Conservation (DEC) has been working on developing a coastal zone management programme for the nation. The Hiri East coast in Central Province, just east of Port Moresby, has been identified as a suitable pilot area for initiating the programme. It includes four Motu villages, several fishing settlements, a small island resort and marina, and the University of Papua New Guinea's Motupore Island Research Station. It also encompasses over 60km of the Papuan Barrier Reef and fairly extensive areas of mangroves and seagrass beds.

DEC held a workshop for the Hiri East village councillors and a series of village consultations aimed at providing information about the benefits of coastal zone management. This revealed significant interest in the idea of developing a community-based coastal wildlife management area in the Hiri East. The next stage was to carry out a survey to collect baseline data for a biogeographic profile of the area which the local communities and DEC can use in developing the management plan. In addition, the survey aimed to train Papua New Guineans in how to plan and conduct future surveys of this sort and to increase the capacity of affiliated institutions to carry out such surveys in other areas of PNG.

The 12-day survey of the reefs, mangroves and seagrass beds was carried out in August 1991 with technical assistance from the South Pacific Regional Environment Programme (SPREP), logistical support from Greenpeace U.S., and other assistance from local groups and government agencies. Most of the leading PNG scientists involved in marine, fisheries, mangrove and seagrass disciplines were involved. Satellite imagery of the area was obtained and over 70 survey sites selected to permit ground truthing. The survey teams are

currently preparing a biogeographic profile of the area.

Activities planned for the coming six months aim to maintain the momentum created by the survey, initiating the compilation of user and use information and facilitating broad based and active community involvement in the programme. These include bringing the results of the survey back to the resource owners, holding village awareness workshops about the impacts of and alternatives to dynamite fishing and conducting participatory village workshops to identify key issues, problems and aspirations of community members.

Lafcadio Cortesi, Pacific Campaign, Greenpeace U.S., 139, Townsend Street, San Francisco 94107, USA.

GULF OIL SPILL UPDATE:

A SURVEY OF THE CORAL ISLANDS OF KUBBAR, QARU AND UMM AL MARADEM

A survey of the coral reefs and islands of Kuwait has been carried out against a background of detailed knowledge of their ecology gathered up to the Gulf War. Although the survey was brief, it showed that the reefs surrounding Kubbar, Qaru and Umm Al Maradem are perfectly healthy. There is no sign of any oil pollution, and it is concluded that the seas surrounding the island have emerged virtually unscathed.

Water temperatures are, however, lower than in the preceeding years, and it is supposed that this is due to the airborne pollution released by burning oil wells. The surface of the island has turned grey from the fall-out. If the winter of 1991/1992 proves to be a cold one, then corals may face temperatures below their tolerances. Macro-algal cover may persist late into the year, impeding recovery from the winter. A survey in the late spring of 1992 will indicate if the reefs can be given a completely clean bill of health.

Extract from abstract of a report to the World Conservation Union (IUCN) as a contribution to the UN Interagency Action Plan for the ROPME region.

Nigel Downing, Ashcroft, Rotherfield Peppard, Henley-on-Thames, Oxon, RG9 5LB, UK.

GLOBAL WARMING UPDATE

SYMPOSIUM "IMPACTS OF CLIMATE CHANGE ON ECOSYSTEMS AND SPECIES" (ICCES)

This symposium, organised by IUCN, RIVM, US-EPA and WWF-International, is being held during the first week of December in Amersfoort, the Netherlands. It aims to develop sound assessments of the impacts of climate change on ecosystems and species. Commissioned expert papers will provide reviews and analysis by leading scientists of potential impacts on individual or groups of related ecosystems, on modelling, and on broad aspects of climate change and its impacts. Bob Buddemeier will be providing a paper on coral reefs.

Workshop sessions will be held to identify key factors and processes governing responses to climate change in selected ecosystems; to identify the possible directions and main features of ecosystem and species responses; and to determine the maximum rates of change which different ecosystems can withstand. These analyses will be used to identify key indicators which might provide early warning of ecosystem collapse. The outputs from the symposium will not only be used to guide the activities of the sponsoring agencies, but will also be published in both popular and scientific format.

Further information from: *Dr Leemans, RIVM, Antonio Van Leevwenhoekloon 9, PO Box 1, 3720 BA Bilthonem, The Netherlands. Tel 31-30-749111. Fax 31-30-742971.*

WORKSHOP ON CORAL BLEACHING, CORAL REEF ECOSYSTEMS AND GLOBAL CHANGE: REPORT OF PROCEEDINGS

As reported in the last issue of *Reef Encounter*, a workshop on coral reef ecosystems and global change was held on June 18-21, 1991 in Miami, sponsored by the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency. Approximately fifty scientists representing disciplines ranging from coral biology, ecology and geology to climate modelling, oceanography, and meteorology, reviewed and produced a series of documents defining the status of present knowledge about coral reefs and the environment, as well as identifying key research and information needs for the future.

A major conclusion was that much subjective evidence exists to indicate that there is a worldwide decline in the overall "health" of coral reefs and related ecosystems, but there are not adequate baseline and survey data to provide a rigorous scientific assessment of the nature and extent of the problem. The group therefore strongly recommended the development and expansion of a scientifically based, internationally coordinated long-range monitoring program oriented toward reef environments and biology.

With respect to the issue of coral reef "bleaching", the group concluded that the recent increases in reported events were indicative of increasing ecosystem stress, and that many of the events appear to be associated with local high temperatures. However, other stresses are also known to cause bleaching, and our knowledge of both coral stress responses and the detailed nature of climate change make it impossible at present to claim that coral bleaching is an early indicator of the greenhouse effect.

In identifying the probable present and future environmental threats, the workshop found that although global climate change represents an important long-term challenge, the most immediate concerns and the strongest stresses and environmental "signals" stem from local and regional anthropogenic sources – the results of

human population growth, land use, resource exploitation, waste disposal, etc. Such effects correlate and interact with environmental signals resulting from longer-term climate change and from natural environmental variability. A matter of particular concern is the sometimes subtle effect of long-term nutrient loading in coastal areas or enclosed basins.

The group endorsed the importance of "retrospective monitoring" – the use of environmental information contained in the chemical and physical records of annual growth bands of corals to reconstruct environmental variations and organism responses of the recent past (see article by Ramy Klein, p. 12).

The group also noted that reefs are not sinks for atmospheric carbon dioxide; contrary to some assertions, on timescales of concern to humans, marine calcium carbonate production results in the release rather than the absorption of atmospheric carbon dioxide. On the scale of anthropogenic carbon dioxide releases however, reef-induced fluxes are insignificant.

Maryland Sea Grant College Publication No. UM-SG-TS-91-03. Copies available from: *Maryland Sea Grant College, Taliaferro Hall, University of Maryland, College Park, Maryland 20742, USA.*

COUNTRY PROFILE

SINGAPORE - RACING TO RESCUE THE REMAINING REEFS

L.M. Chou

Singapore is not the first place one would think of when searching for either exciting reef diving experiences or locations for interesting research projects. Unfortunately there is no information on the diversity and form of the reefs of pre-colonial days, but one could assume that they were on a par with adjacent reefs in Indonesia and Malaysia. However, since 1981, the National University of Singapore has carried out extensive work on reefs in the face of growing threats to them.

Singapore's limited seaspace, which supports the world's busiest harbour, is one of the most intensively used in the world. The rapid rate of development involving large scale foreshore reclamation has increased sediment levels in the water (visibility has decreased from 10 m in the 1960s to a 2 m average today), resulting in the degradation of the deeper coral reef zones. The upper

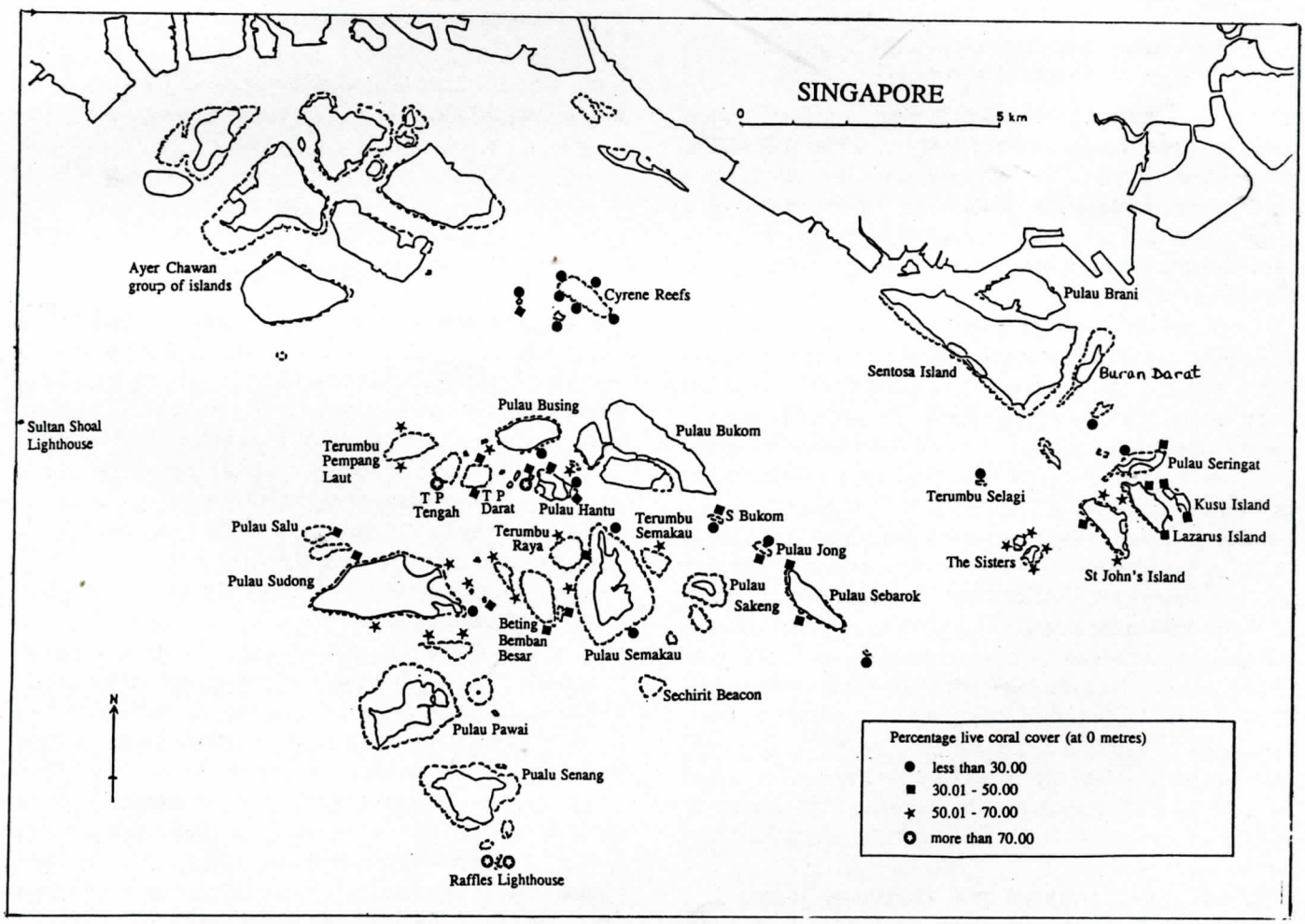

Figure 2: Map of Singapore's southern islands showing conditions of reefs surveyed (based on live coral cover at the reef crest).

zones however continue to maintain good coral growth and species diversity (Chou and Koh, 1986); over 110 species of corals have been recorded (Chou, 1990). Reefs are confined to the southern islands, which stretch some 20 km south of the Singapore mainland, and are mainly fringing or patch reefs. Most work has been carried out at 5 reefs (Cyrene, Pulau Hantu, Hantu west, Pulau Semakau, Raffles Lighthouse) which were selected to represent a transect stretching perpendicularly across the southern territorial waters.

The reefs of Singapore do not have any form of protection at present and much of the current research is directed at their management. A coastal zone management plan is being developed (Chia *et al.*, 1988) and research has been carried out under the auspices of the ASEAN-Australia Co-operative Programme on Marine Sciences. Research work in progress currently includes community structure and stability, colonisation and growth, reproduction, and large-scale mapping with satellite images.

Singapore is fortunate in having a large amateur SCUBA diving community and this has been put to use in carrying out broad-scale survey work. This is discussed in more detail below, as it could provide a useful model for other countries. A second reef conservation project, also using volunteers, was started this year and this is also outlined below.

Using volunteer divers for a reef conservation effort

In late 1987, representatives of three non-governmental organisations, the Republic of Singapore Yacht Club, the Singapore Institute of Biology and the Singapore Underwater Federation, discussed the feasibility of a large-scale reef survey which would form the basis of a reef conservation proposal for submission to the Government.

Between the end of 1987 and 1989, about 150 volunteer sport divers were trained to carry out reef surveys using 100m transects at the reef crest and 3m deep on the reef slope, a method adopted in the region by countries participating in the ASEAN-Australia Marine Science Project: Living Coastal Resources. Since most of the volunteers did not have a biology background, the benthic life-form categories were simplified under four broad categories of hard coral, other fauna, algae and abiotic component. Each of these were further subdivided to give a total of 30 classes including coral growth forms. A training course was run over three nights with intensive use of colour slides to familiarise divers with the categories. They then took a theory test as well as a pool test to check their buoyancy control, before proceeding to two field tests to see how well they could lay the transect tape and record data. Participants scoring more than 90% accuracy in recordings were then allowed to undertake actual reef surveys.

Divers were grouped into 11 survey teams and assigned reefs to survey. Representatives from three organisations accompanied each group on the surveys to ensure they were properly conducted. By early 1990, 65 sites on 41 reefs had been surveyed. Using the single parameter of live coral cover as a sample indicator, 4 sites had >70% cover, 21 sites 51-70%, 22 sites 31-50% and 18 sites <30%. The results are being analysed taking into consideration the other parameters surveyed, and it appears that the better reefs can be grouped into three general areas worthy of some conservation measures. A conservation proposal has been drafted for submission to the Government through the National Council of the Environment in October of this year.

The project has provided useful information on the condition of most of the Singapore reefs (Chou 1991). It could not possibly have been concluded within the present time frame without the enthusiastic participation of volunteer divers.

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Operation 'Reef Rescue'

Helen Newman

Through the auspices of the Malayan Nature Society Singapore Branch and with sponsorship from the Hong Kong Bank, a project has been launched to save some of the reefs threatened by reclamation work in Singapore. Buran Darat is a small island off the east coast of Sentosa Island and is surrounded by a narrow fringing reef about 2 km long. The entire reef will be affected by reclamation work underway to join the island to Sentosa and create a marina and other related developments. In spite of relatively poor visibility, the reef still harbours a good diversity of species.

Corals and other marine organisms are being transported from the Buran Darat reef on semi-submerged sleds to an underwater rock retaining wall that has recently been built on the south coast of Sentosa. The sleds are 2 x 1.2m in size and are made from foam filled pontoons to provide sufficient buoyancy for about 3 sq m of coral and encrusted rock. To remove the large amounts of organisms involved, over 200 volunteer divers have been recruited. The transplanted organisms are being distributed between five 50 sq m areas, the aim being to create five new patch reefs; a control site with no transplanted organisms has also been established.

The granite boulder retaining wall has similar environmental conditions to the original fringing reef in terms of current, depth and rate of siltation. This should help survival of the transplanted organisms. Transplanting is expected to continue until December 1991, when the ongoing reclamation will make further work impossible. The newly created reefs will be monitored photographically and coral growth and fish abundance recorded.

Helen Newman, Marine Conservation Group, Malayan Nature Society, c/o Newman Biomarine Pte Ltd., 60B Martin Rd, #07-01/02, CMDC, Singapore 0923.

WHO'S WHO?

GLOBAL CORAL REEF ALLIANCE

In March, 1991, the Global Coral Reef Alliance (GCRA) was formally incorporated as a nongovernmental, non-profit organization by a small group of scientists, lawyers, and environmental advocates. It is dedicated to the protection and sustainable management of coral reef ecosystems.

The founders, Dr. Thomas J. Goreau, Dr. Rodney M. Fujita, and Mark S. Epstein, believe that funding for the research and protection of marine ecosystems in general, and coral reefs in particular, will continue to lag as long as the public understanding of the severity of the threats facing such ecosystems is poorly understood. GCRA looks to the example of the rainforest movement, which in less than a decade dramatically raised international concern for the world's tropical rainforests.

GCRA's primary goals are to: inform the public and policy-makers of the ecological, environmental, and economic importance of coral reefs; document threats to reef survival; develop policies capable of reversing current worldwide patterns of degradation and advocate their succesful implementation; support the development of marine sanctuaries through research and advocacy directed at abating land-based and transboundary pollution; and design and implement long-term monitoring programmes and research on environmentally sound uses of coral reefs.

GCRA has taken an active role in conveying the concerns of the coral reef community to the countries participating in the PrepCom sessions leading to the 1992 United Nations Conference on Environment and Development (UNCED) and took the lead in drafting a "Coral Reef Protection" statement (see p. 15). In focusing on the UNCED process, GCRA is working with the governments of coral reef countries to ensure that draft treaties to be voted on in Brazil, in June 1992, contain strong language for coral reef protection and sustainable management. In addition to its UNCED work, GCRA staff have also testified before the United States Congress, conducted reearch in the field on coral bleaching, held symposia on the problems of reef degradation, and developed links with scuba diving organizations.

For further information contact: *GCRA Executive Director Mark S. Epstein or GCRA President Dr. Thomas Goreau, at 324 North Bedford Road, Chappaqua, New York, 105149 (Tel. 914-238-8788).*

Preserving those reef encounters

Sunday Times January 1991

We are loving coral reefs to death. All over the world reefs are a magnet for divers and snorkellers who are drawn by spectacular coral formations and the huge variety of colourful marine life they sustain. Unfortunately, reefs just about everywhere are suffering from too many visitors.

BOOK SHELF

ENGINEERING IN CORAL REEF REGIONS PROCEEDINGS OF THE CONFERENCE

Edited by M.R. Gourlay

Published by Department of Civil Engineering, The University of Queensland, Australia 4072. 1991. 305 pp. Copies available from the publishers at $30 plus $6 p&p per copy. ISBN 0 86776 436 8

This conference was concerned with engineering activities within the Great Barrier Reef area and coral reef regions in general. The proceedings are divided into four main sections: (1) Human use of the GBR, (2) Geotechnical, (3) Environmental and (4) Coastal and marine engineering in coral reef regions. A wide variety of subjects were covered including water quality and its effects on reef ecology, tropical cyclone risk and impact, and the role of GBRMPA in the use and care of the GBR.

REPRINTED

CORAL REEFS OF THE WORLD. Vol 1. Atlantic and Eastern Pacific. Vol 2. Indian Ocean, Red Sea and Gulf. Vol 3. Central and Western Pacific.

Edited by Susan M. Wells, with Charles Sheppard and Martin D. Jenkins.

A joint publication of UNEP & IUCN in the series *UNEP Regional Seas Directories and Bibliographies*. Now available again. Complete set (3 volumes) £60, US $ 100. Individual volumes £25, US$45. Available from: *IUCN Publications Services Unit, 181a Huntingdon Rd, Cambridge CB3 0DJ, UK. Tel 0223-277894; Fax 0223-277136, or Island Press, Box 7, Covelo, California 95428, USA. Tel 1-800-828-1302; Fax 1-707-983-6414.*

NEW CONSERVATION JOURNAL

A new international journal, *'Aquatic Conservation: Marine and Freshwater Ecosystems'*, published twice yearly, reports on conservation orientated research in freshwater, brackish or marine habitats. It aims to publish both practical studies in conservation and theoretical considerations of the underlying principles.

Sample copies from: *John Wiley & Sons Ltd, Baffins Lane, Chichester, West Sussex, PO19 1UD. U.K.* Instructions to authors from: *Dr. Philip Boon, Editor, c/o English Nature, Northminster House, Peterborough, PE1 1UA, U.K.*

ANNOUNCEMENTS

VIRGIN ISLANDS ECOLOGICAL RESEARCH STATION

The University of the Virgin Islands operates a small research facility within the VI National Park and Biosphere Reserve for marine and terrestrial researchers, educational classes and workshops. The facility is located in a lowland montane forest adjacent to sheltered bays with coral reefs and extensive seagrass beds, bordered by thriving stands of mangroves. The facility has boats, 15 SCUBA tanks, a Mako air compressor, basic laboratory facilities and a flow-through aquarium. Dormitory-style living accommodation for up to forty students with three meals a day are offered for US$40 per day per person. Research cabins with separate cooking facilities are also provided for $15 per day per person. Researchers, educators and students interested in using the station should contact Dr Norman Quinn at Eastern Caribbean Center, Univ. of the Virgin Islands, St Thomas, U.S.V.I. 00802. Fax: (809) 777-8701.

DIARY

27th December, 1991, Hyatt Regency Hotel, Atlanta, GA, USA.
LONG-TERM DYNAMICS OF CORAL REEFS

This symposium will be held at the Annual Meeting of the American Society of Zoologists, and is organised by Jon Witman and James Porter. Speakers include the organisers plus O. Meier, Terry Done, R. Smith, Nancy Knowlton, Judy Lang, Tom Goreau, M. Colgan, Peter Glynn and Jeremy Jackson. Contact: ASZ (805) 492-3585 for further details.

NOTES FOR CONTRIBUTORS

The aim of *Reef Encounter* is to provide a magazine-style newsletter on any aspect of reefs, the livelier the better. In addition to news, meeting and expedition reports and announcements, we aim to have discussions and debates about particular issues concerning ISRS or the broader field of reef science in general. *Reef Encounter* does **not** publish original scientific data, so please do not submit such papers. The newsletter aims to complement the journal which carries scientific papers only, in that it provides an outlet for book reviews, discussion of papers in the journal and a correspondence column (**Upwellings**). It also carries short reviews of recent trends and developments in reef research or events that bear on reef studies. In the tradition established by the first editor, *Reef Encounter* will continue to be cheerfully illustrated, with cartoons, newpaper cuttings and other entertaining material.

Please note that *Reef Encounter* is an entirely voluntary effort. We do not have funds to pay authors, and the editors are also unpaid. Please help ISRS by submitting material on a regular basis and in a form that does not require too much editing.

To save time and postage, we shall not normally acknowledge submitted material and material will not normally be refereed or returned for corrections. Opinions expressed and errors of fact will have to remain largely the authors' responsibility. No published item should be taken as ISRS opinion unless indicated.

Please help by sending items of not more than 2,000 words in length and in double-spaced typescript, or on diskette using the Multimate, Wordperfect or Wordstar packages, or as ASCII text files. You can expect some gentle editing for flow and sense and to address our readership as appropriately as possible. Illustrations should be of a size compatible with our format. Black line drawings are preferable at present, although we hope eventually to be able to afford photographs. Diagrams should have legends and/or captions to explain all symbols, abbreviations and shading patterns etc. Maps should have a scale and indication of orientation. Use *World List* abbreviations in references. Please use metric, or imperial-with-metric units, but not imperial units on their own. Do not forget to give your name and full address, or any other contact address where applicable.

We have no regular reprint system, but contributors will receive a free copy of the relevant issue.

DEADLINE FOR COPY FOR REEF ENCOUNTER 11 (due out July1992) IS MAY 1ST 1992.

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Send completed application form and your cheque to:

Dr Pat Hutchings, Australian Museum, P.O. Box A285, Sydney South, New South Wales, Australia 2000.