NEWSLETTER OF THE RESEARCH AND MONITORING SECTION

REEF RESEARCH

Great Barrier Reef Marine Park Authority

VOLUME 2 – No. 2 JUNE 1992

EDITORIAL

The Editor would like to welcome 'Slick Talk' to the Newsletter. This will become a regular feature and, given the universal nature of maritime oil pollution, will, I am sure, be of interest to many of our readers. Many of the future articles to be written for 'Slick Talk' will be by authors external to GBRMPA and I take this opportunity to reiterate my invitation to any readers who may wish to contribute articles on any suitable topic to do so and submit them either to the Editor or the relevant program manager.

This issue has managed to glean an article from one of you many researchers out at the coalface and I take this opportunity to thank Rob van Woesik for putting finger to keyboard to write about cyclone damage, a topic about which, among many other things, he has first hand experience.

Another new contributor to Reef Research is Leon Zann who has recently returned to the GBRMPA fold after several years working on fisheries of Western Samoa. Leon brings a wealth of experience to the Research and Monitoring Section and the Newsletter and I am confident that he will be able to entertain and inform through future contributions on a large number of interesting topics.

I am also pleased to introduce the article on our External Advisory Service.

Lastly, I would draw all readers attention to the article on the Strategic Plan that is being developed for the Great Barrier Reef World Heritage Area. Many (probably most) of our overseas readers will have not had access to the draft Plan and I would urge all who are interested in its development to contact David Briggs or me.

Ed.

REEF RESEARCH will be published quarterly by the Research and Monitoring Section of the Great Barrier Reef Marine Park Authority (GBRMPA).

Readers are invited to submit material for publication, inclusion is the decision of the Editor, all contributions or inquiries should be addressed to:

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WHO'S WHO

WHAT'S IN THIS ISSUE

STAFF NEWS

Permanent Positions

John Robertson – Project Officer (Effects of Fishing)

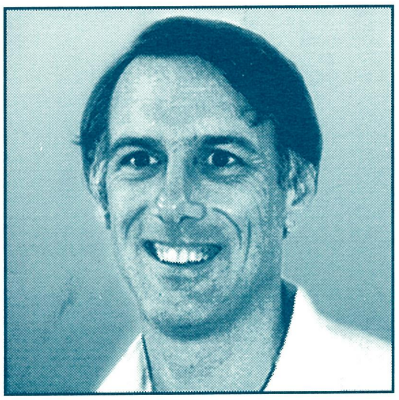
Andy Steven – Project Officer (Water Quality)

Temporary Transfers

Leon Zann returned from South Pacific and took up the task of preparing the State Of the Marine Environment Report

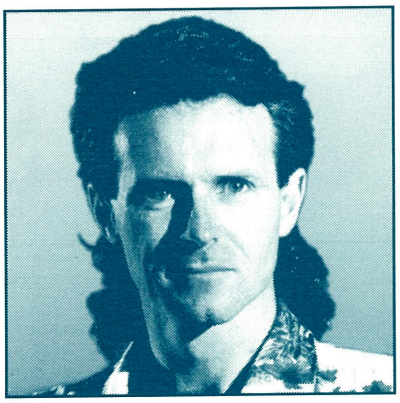
Christine Dalliston – Assistant Project Officer (Effects of Fishing)

William Gladstone – Project Officer (Torres Strait Baseline Study)



James Oliver B.Sc. (Hons), Ph.D.

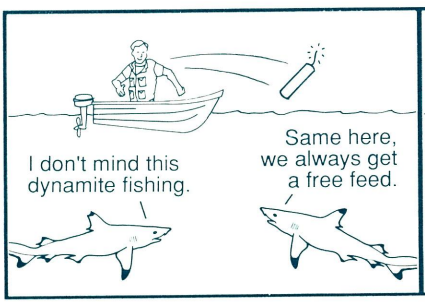
Jamie joined the Authority in March 1991. Prior to coming to us he was a post doctoral research fellow at AIMS. Over the years he has worked for the Authority as a consultant on a variety of projects.
Jamie originally came to Australia from Canada in 1975, studying at James Cook University. He obtained his PhD in Marine Biology studying growth and reproduction in corals and was a member of the JCU Coral Reproduction Group which was instrumental in discovering the spawning phenomenon. His interests include coral ecology, remote sensing, benthic monitoring and larval dispersal.
His main areas of responsibility within R&M are monitoring, coral ecology and physiology, remote sensing, reef benthos, underwater photography, experimental design and personal computers (IBM).



William Gladstone

William has been working at GBRMPA for two years, mostly as Project Manager in the Crown-of-Thorns Starfish Research Program. More recently he has acted as Scientific Advisor to the Torres Strait Baseline Study, collecting sediments and biota and spending lots of time at sea in the Torres Strait. His other consuming interest at work is underwater photography. William has quite a diverse professional history: He was a Biologist at the Fisheries Research Institute (NSW Dept of Agriculture), Senior Tutor in Biological Sciences at the University of Sydney, student of medicine at the University of Newcastle, consultant to the Royal Commission into Aboriginal Deaths in Custody, and consulant to the ABC Natural History Unit during filming of the Bicentennial series "The Nature of Australia".
For his PhD research William studied the behavioural ecology and life history of a species of coral reef fish at Lizard Island over a period of three years, becoming a founding and life member of the LIGFC.

Coralations



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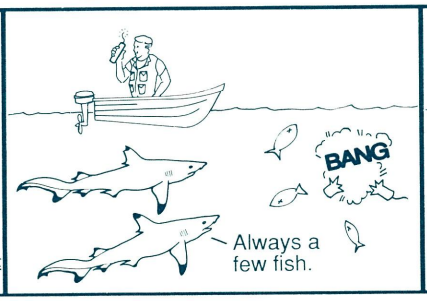

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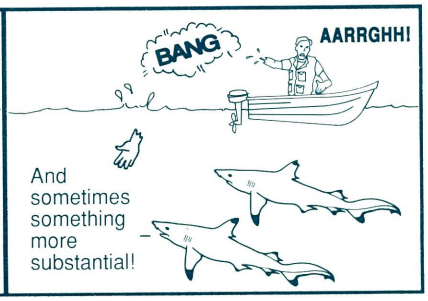

The Great Barrier Reef World Heritage Area –

Strategic Plan and Researchers

Dr Wendy Craik
Executive Officer - GBRMPA

In the March issue of Reef Research, there was a short article on the Great Barrier Reef World Heritage Area Strategic Plan. In this article I would like to point out the relevance of the Strategic Plan to researchers, who may think that it is just another GBRMPA and Queensland Department of Enviornment and Heritage Zoning plan or management plan.

The idea behind the plan came from a variety of sources including the desire to set clear specific objectives for the entire reef area, the desire of day-to-day management to have specific objectives and the views of many of the user stakeholders, (expressed particularly at the "Innovative Ways Workshop" in 1988 and through the Great Barrier Reef Consultative Committee) that they would like to have clear long term ground rules to operate within. It was decided that areas between high and low water, the islands, the World Heritage Area and not just the Marine Park was the appropriate planning unit.

The plan is one that is being developed cooperatively with representatives of the major stakeholders to create a shared 25 year vision and objectives and strategies to achieve that vision. These are being translated into a 5 year plan and review and evaluation mechanisms are also being developed. A consultant, Kayt Raymond and Associates, has been appointed as an independent facilitator/chairperson to advise on strategic planning and process and to run workshops to ensure it is not a GBRMPA plan, but everybodys' plan.

By now many people reading this may have seen a copy of the draft plan - if not, and you want a copy, one is available from David Briggs in the Planning and Management Section at GBRMPA.

Research and monitoring is a particularly important component of the strategic plan. What the plan is trying to do is to set long term objectives for research and monitoring in the World Heritage Area for the next 25 years and specifically, the next 5 years. As the intention is that the plan is voluntarily adopted by all stakeholders, the input of researchers and their agencies in relation to Great Barrier Reef World Heritage Area research is essential. While some of the draft objectives outlined are already in place there are others that have not yet been started, and it may be that important areas have been overlooked - so now is your chance to contribute to the long term research and monitoring program for the Great Barrier Reef World Heritage Area.

Research and monitoring interests in the Planning Team are represented by Professor Helene Marsh from JCU. Dr Terry Done of AIMS has also contributed to the Planning Team deliberations. Dr Craig Johnson (U QLD), A/Prof David Hopley (JCU) and Dr Terry Hughes (JCU) also participated in early workshops. If you have specific comments on the plan contact Helene Marsh or Dave Briggs at GBRMPA.

In reviewing the plan, the questions you should consider are:

1. How does your vision of the future of the Great Barrier Reef World Heritage Area fit with the one presented in the plan?
2. What appeals to you about this plan?
3. What is missing from this plan?
4. How will the plan affect what you do?
5. How will the plan affect the way you think about the Great Barrier Reef World Heritage Area?

We hope to have the plan completed by October 1992.

Welcome to 'Slick Talk', the new regular oil spills column of Reef Research.

As an island nation Australia is overwhelmingly dependant on maritime transport for the conduct of trade and other activities essential for survival in a technological age. As a result there exists considerable traffic of a variety of vessels through Australian waters - many of which carry quantities of oil as cargo and most of which carry some form of oil as fuel.

This presents a very real threat to Australia's diverse, extensive and extremely valuable marine resources from the occurrence of shipping incidents resulting in oil spills.

In response to this threat Australian Commonwealth and State Governments, and industry, have developed various strategies to prevent oil spills from occurring. As prevention strategies can and do fail, the governments and industry have also developed oil spill response plans, which fall under the umbrella of the National Plan to Combat Pollution of the Sea by Oil (the National Plan).

Because oil spill response normally involves maritime operations and requires maritime expertise, at least in the early stages, the response effort normally comes under the over-all control of somebody with a maritime - operational background. This person is referred to as the On Scene Coordinator (OSC) and is usually from a Maritime Authority, Department of Transport or similar body.

However as the primary objective of oil spill response is to minimise ecological impacts , it is necessary for the OSC to be provided with environmental and scientific advice and support. This role is played by a Scientific Support Coordinator (SSC), who usually comes from an environmental management agency. The OSC and SSC work as an integrated team to ensure coordination of the spill response, to achieve the objective of minimising ecological impacts as efficiently and effectively as possible.

Under Australia's National Plan, prime responsibility for oil spills in Commonwealth waters rests with the Australian Maritime Safety Authority (AMSA) which provides or delegates an OSC. In State waters the relevant State maritime authority has prime responsibility and provides the OSC. The SSC function is provided by the state environmental agencies in both cases. Under REEFPLAN, the Marine Pollution Contingency Plan for the Great Barrier Reef region, special arrangements exist with Queensland in that prime responsibility and the OSC role lies with AMSA for all waters below mean low water. The Great Barrier Reef Marine Park Authority provides the SSC and is supported by the Queensland Department of Environment and Heritage in this role.

A vital function of the SSC in pre-spill planning is the collection, assessment and dissemination of information on the scientific and environmental aspects of oil pollution and oil pollution response. One way in which such information is disseminated is via the biennial National SSC Workshops organised as part of the National Plan.

At the 3rd National SSC Workshop held in Fremantle in March 1992, it was agreed that not enough transfer of information was occurring between SSCs around Australia, between SSCs and others in the wider scientific, research and environmental management community, and between SSCs and those involved in the maritime operations area of oil pollution. It was therefore proposed that a national SSC newsletter should be developed to assist with the transfer of information.

As development and ongoing production of such a newsletter requires considerable commitment of staff time and resources it was decided to explore other options such as "piggy backing" on an already established newsletter. Reef Research was therefore approached with the proposal of a regular "oil spills column"; Reef Research agreed and "Slick Talk" was born!

In each coming issue of Reef Research, "Slick Talk" will feature an article by one of the various SSCs in each of the Australian States or by other scientists, researchers and environmental managers involved in oil pollution, as well as any quick updates or news items that may come in. "Slick Talk" will specifically and exclusively address the scientific and environmental aspects of oil pollution, and the articles will include summaries of latest research results, state-of-the-art developments in oil spill remediation, environmental monitoring techniques and case studies of real incidents from around the country. The column will also attempt to have an international relevance and submissions are invited from overseas.

It is hoped that this new column will play a useful role in the transfer of information on this increasingly important problem. Many thanks to Reef Research for taking "Slick Talk" on board, and see you all next issue with our first article.

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EXTERNAL SERVICES PROGRAM

Michelle Morrison

In October 1991 the Authority adopted an additional aim to make the Authority's expertise available nationally and internationally in recognition of the functions of the Authority under S. 7A of the GBRMPA Act 1975 which states "that the Authority may, at the request of another institution or person, provide assistance to the institution or person in matters relating to environment management".

Although the Authority has provided ad-hoc external assistance since 1985,the External Services section was not established until October 1991 with two officers.

The section objective is to facilitate the provision of environmental management advice and technical co-operation and development assistance to approved national and international programs and projects outside the Marine Park.

DESCRIPTION

The program involves the provision of technical co-operation and development assistance and advice on environmental management for the conservation and sustained use of tropical coral reef and shallow water marine and coastal environments through a cadre of highly qualified and experienced professional staff from within the Office of the Authority and its associated agencies. Services are provided to other institutions and individuals generally on a full cost recovery basis.

Since commencing this external services program the Authority has:

- completed three external assistance projects
  - for the Australian Centre for International Agricultural Research assessing the use of remote sensing in the South Pacific;
  - for the IUCN, the World Conservation Union and the Asian Development Bank providing resource inventory input for the Fiji National Environment Strategy Project; and
  - for the South Australian Centre for Remote Sensing assisting Malaysian marine park management plan development.
- been selected as part of a project team managed by Nicholas Clark and Associates to undertake development of a National Tourism Plan for the Kingdom of Tonga. This is an Asian Development Bank funded project.
- entered into an agreement with the World Bank to provide technical advice and mapping in developing priority areas for the conservation of global marine biodiversity.
- signed a memorandum of understanding with the United Nations Environment Program to, inter alia, provide preparatory project assistance to the Global Resource Database (GRID) Pacific project.
- completed an inventory of the professional skills experience of the Office of the Authority staff.
- commenced registration with national and international implementing and donor agencies, such as AIDAB, World Bank etc.

Nationally, the section is responsible for the coordination of the Authority's involvement in the development of a national system of Marine Protected Areas. This initiative was announced by the then Prime Minister, Mr Hawke, in late 1990. As a result, the Minister for the Department of Arts, Sport, the Environment and Territories (DASET), the Hon. Ros Kelly MP, announced the establishment of Ocean Rescue 2000, a decade-long program to protect the marine environment.

There are 6 components to the first stage of Ocean Rescue 2000:

- the development of a national marine conservation strategy;
  :to be undertaken by DASET
- the development of a state of the marine environment report;
  :to be undertaken by GBRMPA
- the development of a national system of marine protected areas;
  :to be undertaken by DASET, GBRMPA and Australian National Parks and Wildlife Service (ANPWS)
- the develcpment of a national education program.
  :to be undertaken by GBRMPA
- the development of a marine spatial information system
  :to be undertaken by Environmental Resource Information Network
- the development of a Torres Strait Island and Aboriginal component
  :to be undertaken by DASET, GBRMPA and ANPWS

The responsibilities of the Authority with the Marine Protected Area program are to administer funding and provide technical advice as requested to the States and Territories through the Marine Protected Areas Establishment Task Force, particularly relating to regional planning and multiple use.

The ANPWS and GBRMPA have established a cooperative program with relevant State/Territory agencies for the establishment and management of marine protected areas around Australia. Projects funded to date have related primarily to preparing inventories and classifications of marine habitats as well as the declaration of marine protected areas.

So far, the Authority has been involved in developing projects with the Northern Territory, Queensland and Western Australia. Some initial discussions have been held with Victoria, which has expressed an interest in the management of the GBRMP as a useful model for them to consider, and New South Wales.

The section is also involved in administering funding and assisting the Torres Strait Island Co-ordinating Council in the development of a marine conservation strategy for Torres Strait.

CORAL BLEACHING

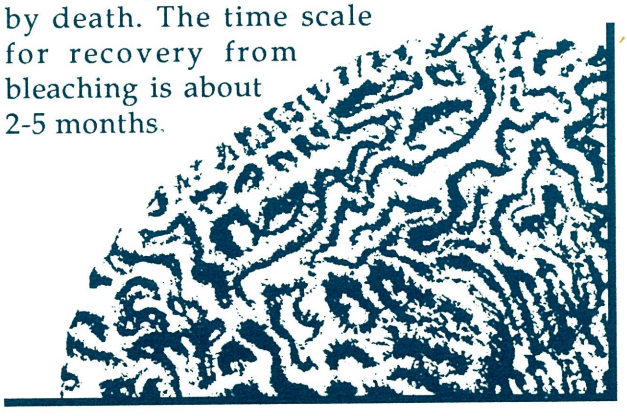
Rick Schneider & Jamie Oliver

In the last issue of Reef Research, attention was drawn to the phenomena of coral bleaching and a questionnaire was distributed to readers. Many thanks for those forms which we have received. We continue to ask all reef-users to report any observations of coral bleaching, in order that all such events can be documented in as much detail as possible.

BLEACHING – The Causes

Coral bleaching refers to a process in which corals suffer the loss of the algal cells (zooxanthellae) that normally live within their tissue. These algae give corals their characteristic brownish colouration and also contribute substantially to the nutrition and skeletal growth of the coral. Once the algae have been lost, the white coral skeleton can be seen through the transparent coral tissue, giving it a "bleached" appearance. Bleached coral looks very similar to coral which has recently died, but can be distinguished (on close inspection) by the presence of small polyps and tentacles on the coral surface. Coral which has been dead for more than a few days acquires a coating of green or brown algae and is thus readily distinguishable from bleached coral.

The actual process of bleaching is poorly understood, and it is not clear exactly why bleaching occurs. What is known is that bleaching occurs if a coral is exposed to conditions which cause it to become stressed. Examples of these conditions include high and low temperatures, low salinity and lack of light for algal photosynthesis. The thresholds beyond which these conditions may cause stress and bleaching may vary between species and between individuals of a species, (e.g. the capacity to deal with high light intensities is likely to be greater in an individual which is regularly exposed at low tide compared to one which is rarely exposed.) The ability of corals to survive a bleaching event and to regain their zooxanthellae is dependant on the species in question and on the extent of the bleaching. If the initial stress is sufficiently severe or prolonged, bleaching is followed by death. The time scale for recovery from bleaching is about 2-5 months.



The factors most often implicated as the major causative agents of bleaching are temperature and light. In many cases of widespread bleaching however no individual environmental factor has been particularly excessive. One possible explanation for occurrences of this nature is that a number of environmental parameters, none of which are at the extremes of the range bearable by a coral but nonetheless higher or lower than those which could be considered optimal, are acting together to induce a stress response. This unified action of factors may be cumulative or synergistic (where two or more factors acting together have a greater effect than would be expected through merely adding together their individual effects). Temperature and light have been shown to have a combined effect whereby heat stressed but unbleached corals have become bleached when exposed to high light intensities.

The issue of bleaching was dramatically thrust into the public arena in 1982-83 when coral bleaching and mortality occurred on a global scale. Much of this bleaching was attributed to environmental anomalies associated with the El-Nino Southern Oscillation (ENSO) event occurring at that time. ENSO is a periodic (approx 5-yearly) climatic event involving global changes in atmospheric and oceanographic processes. The 1982-83 event was one of the most severe of this century.

Further work on corals in the Great Barrier Reef however has failed to conclusively demonstrate that bleaching is related to ENSO events. It has been shown that bleaching can result from other oceanographic and meteorological anomalies and may occur seasonally during mid to late summer on the Barrier Reef.

RELEVANCE TO MANAGEMENT OF THE GREAT BARRIER REEF

Human influences on the reef, such as the introduction of contaminants and nutrients may contribute to the stress load encountered by corals. While it is unlikely that these contaminants will be present at high enough levels to directly cause bleaching, they may lower the resistance of corals to natural disturbances such that bleaching and other stress reactions occur at lower thresholds of natural disturbance i.e. act as "the straw which breaks the camels' back". It is thus highly important that knowledge is gained of "natural" (or at least current) bleaching events, so that there is a baseline database with which to compare future events. Comparison between events may have the potential to act as an early warning indicator of man-induced stress on the reef.

It has also been suggested that coral bleaching may have the potential to act as a sensitive indicator of global climatic changes, in particular those associated with the greenhouse effect. If this method is eventually utilised as a means of monitoring global changes, it will be important to have baseline information available.

Despite the lack of evidence linking ENSO to bleaching events, it is still possible that periodic bleaching is related to large scale regional or global anomalies. For this reason also it is essential that we continue to collect accurate information on the extent and severity of bleaching over the next several years or decades.

THE CURRENT SITUATION

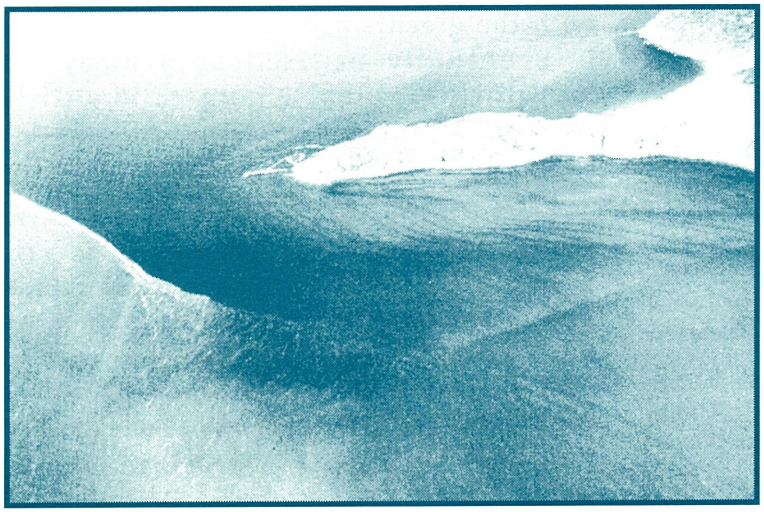
As reported in the last edition of Reef Research, substantial coral bleaching was observed at Magnetic Island at the beginning of the year. A GBRMPA team has since then conducted quantitative coral surveys backed up with video and a coral tagging program at the Island. While the results of the survey have yet to be fully evaluated, we can report that the majority of bleached corals appear to be recovering.

Other coral bleaching reports we have had back report bleaching occurring in the Keppel Islands, the Whitsunday Islands and in a few isolated patches on Heron Reef. Please keep us informed of any bleaching which you observe on the reef (pre-paid reply forms are available from GBRMPA).

Direct and indirect effects of TROPICAL CYCLONES

Rob van Woesik [1].

Episodic disturbance has been considered by some ecologists as essential for the maintenance of local diversity in tropical ecosystems by preventing space monopolisation by fast-growing, opportunistic, species. Cyclones are amongst the most severe physical disturbances to impact on coral reefs. Until recently it was largely unknown the degree to which tropical cyclones effect the structure and composition of coral reefs on the Great Barrier Reef. Effects may be direct, including removal of reef matrix, scouring and fragmentation, or indirect, as in the reduction of salinity and light levels following intense rainfall. Whilst the former effects are well documented the latter are less well understood.



Freshwater plume associated with Cyclone 'Joy'. Note the sharp deliniation between saltwater and freshwater to the left of the Keppel Islands – 1990.

Direct effects

Direct effects extend from the removal of the entire reef matrix (with the exception of a few broken stumps, some encrusting and occasional massive species - leaving only rubble and bare carbonate substrate) to patchy disturbance and occasional colony breakage induced by flying debris. In the immediate impact area there are also obvious declines in small planctivorous fishes, which use coral as a refuge. The amount of disturbance is dependent on the intensity of the cyclone, the fetch distance, shelter by neighbouring reefs and the reef slope angle.

Cyclones create extensive areas of bare substrate, primed for recolonisation. These events initiate shifts in community structure which are offset by regrowth and recruitment. Recovery of smaller patches are largely by regeneration of remnant patches and marginal ingrowth, however, large patches are entirely dependent on larval recruitment. Cyclonic swathe widths are retraced approximately every 13 to 15 years and physical disturbance appears frequent enough that only fast-growing species (especially *Acropora* spp. - Staghorn corals) can dominate the slopes of the outer reefs.

Cyclone 'Ivor' (965 Hpa) passed over the outer reefs in the Lizard Island region (14°09'S,145°00'S) in early 1990 and caused severe damage within a 50km arc drawn from the cyclones centre and was detectable, although patchy, some 100km south and 40km north from this point. The back slopes of the outer reefs were not affected except for reefs in the northern extreme of the cyclone's trajectory. Damage was intense, although patchy, inside the outer barrier reef.

Indirect effects

Cyclone Joy' (940 Hpa) caused considerable damage to reefs off Cairns (16°40'5) in late December 1990. It degenerated into a tropical rain depression. Extensive rainfall (over 2000mm) associated with the depression in late December 1990 and early January 1991 led to some of the most intense flooding the Queensland coast has experienced for 100 years. The indirect effect of the cyclone was assessed on inshore reefs in the southern Great Barrier Reef.

The Keppel Islands are located in the direct vicinity of the Fitzroy River mouth (the largest river in Queensland). Prolonged reductions in salinity caused a considerable decline in live coral biomass. The dominant coral genus *Acropora* was most affected.

Located 300km to the north, the Proserpine/O'Connell Rivers flow into Repulse Bay, immediately to the south of the Whitsunday Islands, however, the recent construction of a dam precluded any intense river run-off. On reefs in the Whitsunday region, there was minimal mortality amongst shallow corals, except Acropora spp., however many deep water pocilloporids (eg. *Seriatopora hystrix*) at 5-6m were killed.

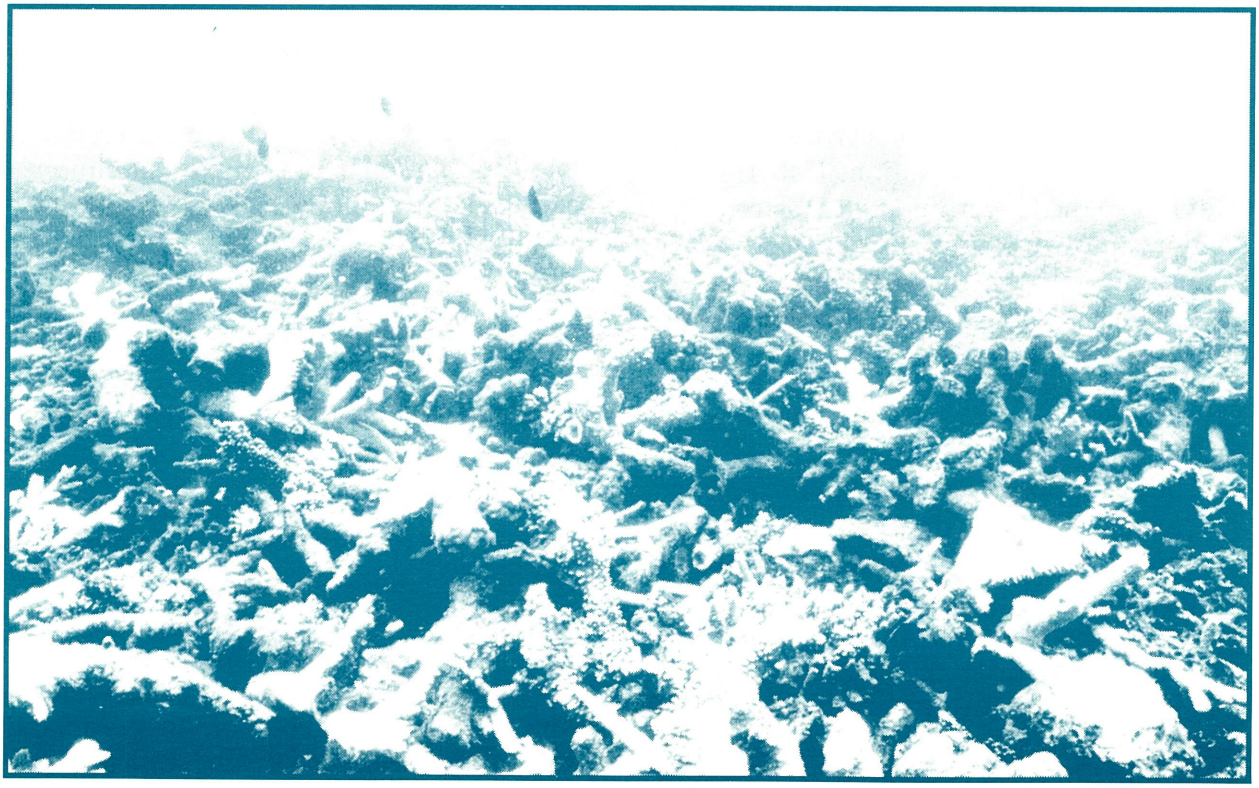
It appears that light penetration was minimal during the monsoonal passage and was probably responsible for deep water mortality. Reductions in ambient light result from high levels of turbidity and organic detritus in the water column, but also because of planktonic blooms; a consequence of nutrient increases through terrestrial discharge and inter-reefal sediment agitation.

The coral species most affected by the flood disturbance were opportunists (ie. *Acropora* spp. and pocilloporids), a definition given to species that have the following traits; fast-growing, less dense, settle quickly and locally and metabolise faster. These traits suggest an ephemeral nature which allows species to maintain a high reproductive output and undergo rapid growth on settlement. However, these type of species appear most vulnerable to physico-chemical stress.

Periodic exclusion of such opportunists may be essential in maintaining regional diversity on long time scales. Although the monsoonal passage only reduced coral cover marginally in the Whitsunday Islands, select mortality of monospecific colonies creates space for recruitment of other coral species. Mild disturbance events appear to prevent space monopolisation by fast-growing species, effectively enhancing diversity on a local scale. On the other hand, the Keppel Islands are located close to the Fitzroy River mouth, and episodic floods eliminate entire assemblages. Diversity is reduced in these situations, especially when the time between disturbances is short.

It is vital to assess the recovery period of coral reefs in many different geographic circumstances after natural disturbance events. Understanding these events will allow us to ascertain whether anthropogenic impact has any effect on the recovery process of coral assemblages.

1. Researcher, James Cook University and Consultant for the Great Barrier Reef Marine Park Authority.



Reef matrix destruction at Lizard Island following Cyclone 'Ivor' – 1990.

SOME PERSPECTIVES FROM the Pacific Islands

Leon Zann
Coordinator
State of the Marine Environment Report for Australia
GBRMPA

Over the past 15 years I have spent about equal amounts of time on the Great Barrier Reef and in the small, scattered islands of the South Pacific. My love affair with the islands began when I lived in Fiji while Lecturer in Marine Biology at the University of the South Pacific. Between 1979-85 I worked in most of the 12 island nations of the university region, and in Papua New Guinea and the Federated States of Micronesia in the northern Pacific. I joined GBRMPA in 1985 as Senior Project Manager and became Coordinator of the Crown-of-Thorns Starfish Research Program. This gave me some important perspectives on the prickly areas of management and science, and on politics and the media in Australia.

It was with some relief that, in 1990, I returned to the Islands for a two year assignment as United Nations Fisheries Adviser to the Government of Western Samoa. I now find myself back in Australia, with some valuable perspectives on coral reefs, conservation and life in general from my Pacific sojourn.

The Islands

The small South Pacific Islands to our east are as diverse as they are scattered. The Solomons, Vanuatu and New Caledonia are high island islands inhabited by the dark Islanders, the Melanesians. Tonga and Samoa are mainly small, high islands, and the cradles of the seafaring Polynesians. Fiji is a large group of mainly high islands, and is the vibrant meeting place of Melanesia and Polynesia. Tuvalu, Tokelau, the Northern Cooks and northern French Polynesia are tiny atolls inhabited by Polynesians, while the Kiribati atolls are peopled by the more Asian Micronesians.

For most Australians these names are unfamiliar, and the Islands are probably little more than flyspots on the Pacific map. But to the Islanders Australia is 'big-brother', dominating their western horizon and their economies.

A key reef species

The small islands hold a particular interest for me because of a key organism on their coral reefs. This species first arrived in the Western Pacific Islands between about 20,000 to 5,000 years ago, at an early stage in Holocene reef formation. It gradually spread eastwards across the vast Pacific, reaching even the most remote islands.

Although it depended on coral reefs for food, its populations were low and caused little damage to the reef ecosystem. However, around 30-50 years ago it suffered a major population explosion, threatening coral reefs throughout the South Pacific.

That species is not the coral-eating crown-of-thorns starfish *Acanthaster planci* but *Homo sapiens.*

Traditional conservation of coral reefs

We can learn a lot about environmental management from the Pacific Islanders who have lived on their small islands and reefs for many millennia, in apparent balance with their environment. Traditionally the Islanders have a holistic view of their environment. The translation of the word 'land' ('vanua' or 'fanua') means the total of the

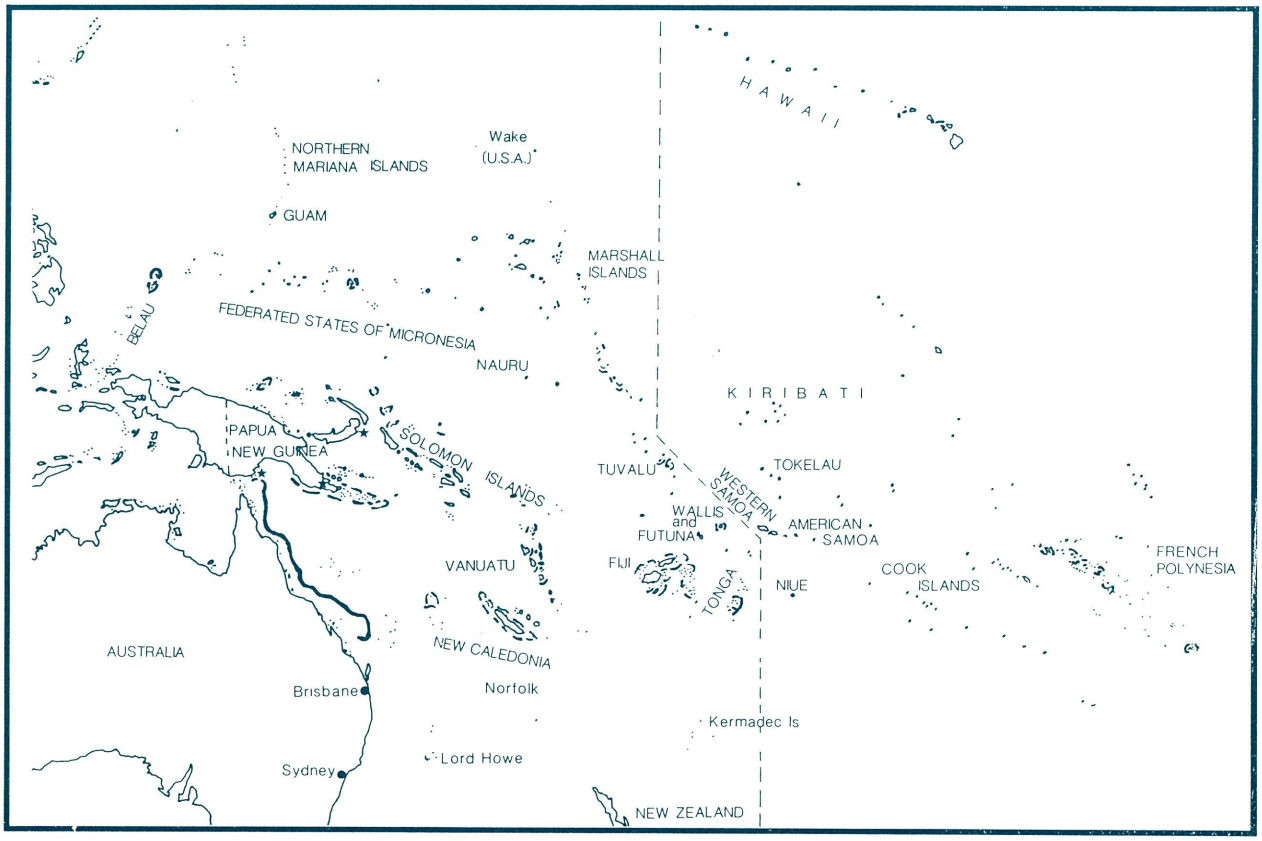
soil, rocks, streams, plants and animals, air, ocean, reefs, fish, waves and wind, and the people (ie 'ecosystem'). Land cannot be bought or sold. It belongs to the clan or tribe, dead ancestors and unborn future generations.

As resources of small islands are particularly finite, customs evolved to avoid over-exploitation of resources. Populations were traditionally controlled by warfare, birth control, infanticide, food and disease. By custom, food and possessions must be shared within the clan and community, discouraging acquisitiveness.

The atoll people in particular live close to the ocean. The Central Pacific oceanic atolls are amongst the most isolated, infertile and precarious environments on the planet. The total land area (26 sq km) of the nine small atolls and islands of the independent nation of Tuvalu would be lost in the centre of Sydney. Its capital (Funafuti, population about 1,500) has the population of a large apartment block. The national population is that of a small Australian county town (9,000). Yet its sea area is 1.2 million sq km (about four times larger than the Great Barrier Reef Marine Park).

Tuvalu's coral reefs are limited in area and their fisheries are generally reserved for times of bad weather, or for the elderly or disadvantaged. The fishermen target the migratory, oceanic species and developed a variety of fishing techniques for flyingfish, tunas, billfish, wahoo, and deepwater bottom fish. The master fishermen (tautai) are the most esteemed members of the community and tuna and flyingfish are the staple foods on most islands. Social factors and customs indirectly relieve pressure from reefs. Small reef fish, shellfish and seaweeds are derogatorily referred to as 'old men's food' by the young strong fishermen. (One atoll in neighbouring Kiribati which is blessed with a large, rich reef is known as 'the island of old women' as they do not fish for tuna like their neighbours.)

Traditionally, in many Pacific islands overfished areas and vulnerable species might be protected with a 'tapu' (taboo), a Polynesian word. Turtles were traditionally reserved for the chiefs. (In Fiji a commoner could be killed for catching a turtle.) The efficiency of traditional conser-



Island countries of the South Pacific.

vation practices can be judged by the disasters which have occurred since Westernisation.

Environmental degradation following Westernisation

Westernisation resulted in the breakdown of many traditional management practises in the Pacific Islands, while overpopulation, the advent of the cash economy, urbanisation, industrialisation and commercial fisheries have placed severe pressure on coral reefs.

The list of extinctions is growing. The giant clams (*Tridacna gigas, T. derasa* and *Hippopus hippopus*) are recently extinct in many islands. Turtles are headed towards extinction in the next decades. Fish and corals are being devastated by fish bombs and poisons, introduced gill netting, and the extra burden of mouths to feed. Reefs adjacent to urban areas have been severely degraded by pollution, including heavy metals, nutrients, and silt. Crown-of-thorns starfish outbreaks are now chronic in some parts of the Pacific.

Suva, Fiji's capital, has the highest concentrations of tributyl tin (a component of anti-fouling paint) of any port in the world. Pagopago, American Samoa's capital has very high levels of heavy metals (lead, cadmium etc) and fishing has been banned in the harbour area. Apia, Western Samoa's capital, has high siltation, nutrients, eutrophication, faecal bacteria etc, and the adjacent reefs have structurally and functionally collapsed. Western Samoa's main island, Upolu, has suffered stock overfishing (collapse of serranids, mullet, trevallies, scads etc) and ecosystem overfishing (extinction of giant clams, virtual extinction of stingrays etc). The fishing pressure is around 1000 times greater than the average for the Great Barrier Reef.

Scientific perspectives

The Great Barrier Reef is vast in size, complex in structure and function, and incredibly variable in time and space. The human population pressures are generally so low in magnitude and subtle in action that it is very difficult to establish any clear evidence of human impacts through experimentation and monitoring. Little wonder that the causes of the crown-of-thorns outbreaks, the effects of nutrients, the effects of overfishing etc. have remained obscure.

The islands of the South Pacific are 'microcosms' of the larger GBR. They are excellent 'natural laboratories' in which to empirically examine the effects of unregulated human impacts. The groups are often very widely separated, offering some 'scientific controls'. Within each group there are intact reef ecosystems with minimal human use, and reefs in which population pressure, fishing pressure, terrestrial run-off, pollution etc are extreme.

We can learn a lot about coral reefs and how to manage (and mismanage) them from the Pacific Islanders, past and present. R