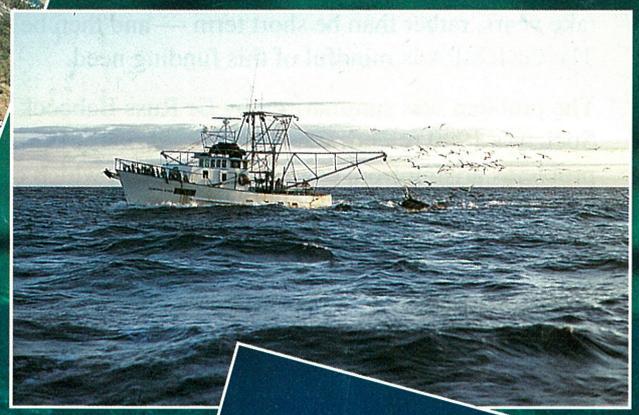


FREE
NO
26
ISSUE

REFLECTIONS

 Great Barrier Reef Marine Park Authority

SEPTEMBER 1991



**PEOPLE PRESSURES
ON THE REEF**

This issue of Reflections is dedicated to the effects that human activity, as against natural cause-and-effect, is having on the whole environment, comprising so many interconnecting ecosystems, of the Great Barrier Reef Marine Park.

Many of the islands and much of the adjacent coast of the region have come under increasing pressure from population, industrial, land-use and tourism growths.

What has become increasingly imperative for future sustainable management of the Reef is for planners, managers and researchers to approach the Reef's environment as part of the continuum of land and sea. Increasingly, we have become aware that what happens to the adjacent coastal lands has consequent impacts on the marine environment not just close to the coast but quite far offshore.

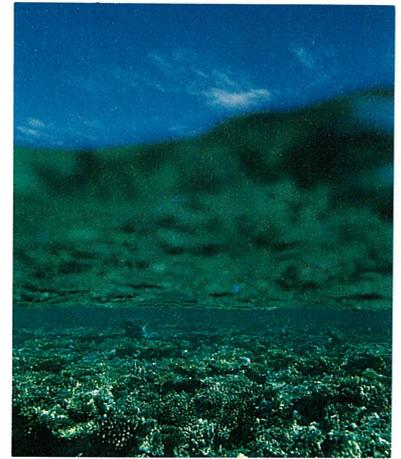
The articles in this issue present a picture of cooperation to try to better understand and better manage the human impacts that are putting stress on the Reef from so many directions. They also intimate the dangers of not taking preventative measures now, rather than later, for many of the adverse effects of human impact may not show up until at destructive levels — and, even then, perhaps very far from the source of the pollution.

There is a great need for much more research funding to study human-activity effects, if only because such studies, by the very wide-reaching nature of the impacts, must take years, rather than be short term — and then be analysed for collective context. The GBRMPA is mindful of this funding need.

The problem was summarised by Dr Russ Babcock after the Australian Coral Reef Society's 1990 scientific meeting: '... serious efforts are being made to address the problems arising from coastal development which confront the GBR. It was plain that there is still much to be learned. This was apparent in the need to provide better links between physical and chemical processes in the environment and their biological and ecological consequences. Only when this is done will we be able to shift from monitoring impacts to predicting them'.

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Front Cover: Aspects of people pressure on the Reef are shown against this unusual image of a reef flat photographed at Lady Musgrave Island. We've also included a people pressure poster on the centre pages.

Reflections is published twice a year by the Great Barrier Reef Marine Park Authority. It does not necessarily represent the views of the GBRMPA.



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CROWN-OF-THORNS LATEST

The Australian Institute of Marine Science continued to survey reefs of the Park for crown-of-thorns starfish. The Institute's team visited the Lizard Island, Charlotte Bay and Cape Grenville sectors during November and, in January, the sectors around Cairns, Innisfail and Cooktown. The November Survey, involving 25 reefs, 12 for the first time, did not observe any large aggregations of the starfish, nor any adverse effects on the reefs. The January excursion, involving 25 reefs, six for the first time, also did not find any adverse activity of the starfish in the region.

The AIMS team is now observing and recording giant clams for GBRMPA as part of its regular surveys.

James Cook University scientists, led by Dr Maurice James and Ian Dight, are studying the unusual ribbon-shaped reefs that lie north-east of Cooktown. These reefs seem to shelter the larvae of marine animals and organisms from ocean currents, including the larvae of the crown-of-thorns starfish. The team is investigating whether these peculiar reef formations are the cradles for population explosions of the starfish.

CYCLONES, FLOODING STUDIED

Tropical cyclone disturbance may be an important factor in the high coral diversity of the Great Barrier Reef, according to a report by JCU scientists Dr Bruce Mapstone, Dr Tony Ayling and Rob Van Woessik. They came to this postulation during their study of the effects of Cyclone Ivor on the far northern reefs around Lizard Island, during which there was massive coral damage. The study might find that diversity of coral species could even be stimulated during subsequent regrowth and recolonisation processes on cyclone-damaged reefs.

In the shorter viewpoint, Cyclone Joy's effect on the sea-bird nesting ground on Michaelmas Cay caused debate among Queensland National Parks and Wildlife Service officers and tour operators. The tour operators denied reports that as much as 90 per cent of the cay's bird life had disappeared during the cyclone. They claimed the birds were returning. The then acting Regional Director of the Q.NPWS in Cairns, Mr Geoff Kelly, called for operators to take special precautions on the cay following Joy, because it had become evident that some 4000 eggs and 2000 juveniles had been lost to date and the breeding ground needed time to rehabilitate without too much human interference.

GBRMPA kept a close watch on the effects of the record floods caused by Joy. The survey involved reefs around the Fitzroy and the Burdekin rivers outflow areas to see how badly they were affected by fresh water run-off on such a massive scale. The flooding Fitzroy River reduced salinity considerably around the Keppel Islands for some 19 days. Coral reefs on the leeward edge (west) of the islands suffered substantial damage with up to 85 per cent of the coral in the top 1.5 metres dying and being overgrown by turf algae. On the windward edge only about 5 per cent of the established colonies were overgrown with turf algae.

REEF EDUCATION AWARDS

GBRMPA's *Reflections* magazine and the book *Discover the Great Barrier Reef Marine Park* have won international acclaim. *Discover ...* won a first place for excellence in interpretive communications in the book category of the US National Association for Interpretation 1990 awards. *Reflections* won second place in the magazine category.

IUCN: PERTH, NOVEMBER 1990

At the week-long conference of the world's leading conservation body, the International Union for the conservation of Nature and Natural Resources, the Prime Minister, Mr Hawke, declared that Australia would work towards establishing a national representative system of marine protected areas. More than 1400 delegates from 120 countries heard that Mr Hawke envisaged, with the cooperation of the various State and Territory governments, a series of sea reserves around the Australian coast in which only appropriate uses would be allowed.

REEF PILOTS NOW COMPULSORY

In November, the Federal Government announced a compulsory reef-pilotage scheme, in which all ships of 70 metres and over must carry a professional pilot when navigating through the Marine Park. The scheme also forces all tankers, chemical carriers and liquefied gas carriers, regardless of size, to have a pilot on board when moving through the northern part of the Reef and through Hydrographers Passage, near Mackay. The announcement was widely praised for its measures to reduce the possibilities of disastrous environmental damage from shipping accidents.

Prior to the introduction of the compulsory scheme, a voluntary scheme had been put in place in 1987. But it was found that, of the estimated 2000 ships longer than 100 metres passing through the Marine Park each year, about ten per cent were not using pilots.

INVENTORY AWARD

The inaugural IBM Conservation Award has been won by a marine biologist who developed a computer database on the resources of the Great Barrier Reef. Mr Edward Hegerl created his inventory of both the natural and human-use resources of the 3500 reefs and 1200 islands that comprise the world's largest coral system. It took him eight years to develop the database that has already become an invaluable conservation and management tool for government agencies and private researchers alike.

CONFERENCES

ECO TOURISM

23-25 September 1991 - Queensland University
An international symposium on educational tourism.
Continuing Education, University of Queensland
Telephone (07) 365 7000, Fax (07) 870 5080

RENEWAL & REPRODUCTION

ANZAAS 60th Congress
1-3 Oct 1991 - Adelaide

KELP to CORAL - caring for our coast

2-6 Oct 1991 - Sydney University
National conference of the Marine Education Society of Australasia
Further information from John Tomkin on (052) 52 0111

PROTECTION OF MARINE & ESTUARINE AREAS

First National Conference
9-11 October 1991 - Canberra
Further information from Australian National Parks and Wildlife Service on (06) 250 0353, Fax (06) 250 0399

TOWARDS ENVIRONMENT 2001

23-25 October 1991 - Canberra
The Environment Institute of Australia
Designed as a forerunner to the UN Conference of Environment and Development (UNCED)
- Brazil June 1992.

THE UNDERSTANDING IS GROWING



In the last few decades — such a tiny proportion of its living history — the Great Barrier Reef is under new threats from forces unleashed by the presence of so many human beings existing near it. Its sanctuary, the surrounding clear blue tropical seas, is being polluted in places, just as our air is over some cities. There is a growing invasion of harmful chemicals, of sediments, of nutrients and algae.

Added to that is the sheer numbers of human beings visiting some pieces of that sanctuary — thousands each and every day. The sum total of even their minor impacts from anchors, walking, collecting, snorkelling and diving are starting to add up to a possible detriment to its health.

The effects might not even be immediately obvious or 'on-site'. They might take years to become apparent, or they might appear well away from the point of impact. We are only now coming to understand the many ways and means that human impacts can manifest themselves, and how, in the short and long term, they might be controlled so that the Reef can survive despite them.

But the prospect is not as dark as it may seem. Gaining an understanding of the whole picture of human impacts is the first step on the path to managing for renewable use of a renewable resource, and this end has become a major thrust in research for so many of the scientific, government, private-enterprise, school and community groups of the Marine Park environs. As the pieces of the jigsaw start to come together, more relevant management-plan necessities are beginning to emerge.

Peter Ottesen, an Assistant Executive Officer of GBRMPA, has presented papers on human impacts at international forums. Following are selections from his writings.

Most Australians live on the coastal margin and population growths there have been highest in recent years, reflecting more intensive agriculture, expansion of the mining and tourist industries. Demand for more cleared agricultural land, roads, harbour facilities, and housing, and rubbish disposal is high with impact affecting the coastal wetlands and associated fauna, and extending offshore to fringing and mid-shelf reefs.

Rainfall along the coast is high and large quantities of sediment liberated by clearing and construction activities are carried out to sea. The resultant increased turbidity can reduce light and stress inshore corals and seagrass beds. Also, mainland run-off carries quantities of agricultural chemicals and fertilisers, with research showing an increase in terrigenous sedimentation on some mid-shelf reefs correlating with algae growth and hard coral loss.

Tourism is the fastest growing activity, encompassing transport, accommodation and recreational activities, as both local people and visitors become more leisure orientated.

The effects of resorts development include loss of wetland communities, dredging adjacent to fringing reefs for harbours, and pollution from sewage discharge. Offshore pontoons have become more elaborate with greater facilities for diving, snorkelling, coral viewing, accommodation facilities. Their location requires site works, and they can impact through the shading of the bottom, waste disposal, heavymetal release, anchor damage, storm damage, and loss of amenity and wilderness values for other users.

Diving popularity has led to crowding at popular sites, anchor damage, fin damage and increased hazards to human safety.

Private boat use has increased enormously and to service and house these, there is a demand for marinas — for which construction often causes destruction of marine life and sedimentation. Marinas also concentrate heavymetals and petroleum hydrocarbons, chronic sources of pollution.

There are also the continuing impacts of commercial and recreational fishing. Trawling remains of greatest immediate concern, not only because of the sustainability of target species, but also through physical disturbance of habitat and the taking of by-catch species (about six times the volume of the target species).

Recreational anglers harvest stocks close to the coast, probably even more than commercial fishermen in these areas. The full impact of amateur fishing is unknown, but this impact could be substantial.

However, the positive impact of these activities cannot be ignored. More people are able to get access to, and to enjoy the Marine Park, which is one of our main management objectives. As well, pontoons shift and spread the impacts away from islands. If impacts are excessive, then it is possible to move them, an easier task than removing a resort constructed on an island.



High nutrient levels in agricultural run-off may threaten inshore reefs.

It is axiomatic that the quality of water in which a coral reef lives is of the utmost importance to that reef, just as much as the quality of the air we breathe is vital to our own health. But it has only been in recent times that a coordinated approach to try to understand the major processes that affect the quality of water in the Marine Park has been made by a cross-section of government, scientific institutions, industry and producer bodies.

There are few doubts today that land use affects the sea environment in which reef and coastal marine systems have to live — land use that arises from urban development, agricultural practices, industry discharge and increased tourism infrastructures.

At a recent workshop to discuss the potential impact of land use on the Great Barrier Reef held at James Cook University, all representatives were unanimous in their concerns about nutrients and sediments washing into the coastal waters.

Other initiatives are happening all around the region — from the study of ‘down-stream’ implications by Landcare groups to the work of the federal and state governments. The Queensland Government’s recently announced Coast Protection Strategy is symptomatic of the wide awareness of the urgency of this problem. It involves all levels of government, as well as commercial fishermen, developers, local communities and anyone with local or regional knowledge.

GBRMPA now commits a quarter of its research and monitoring budget to water quality, with the central aim that the present levels of nutrients in the Reef’s waters should not be allowed to increase through growing human impacts.

*Below is a harvesting of writings by **Jon Brodie**, Senior Research Officer of GBRMPA, about the problems of maintaining water quality in the Great Barrier Reef, where modern-day human impacts are so many and so varied, and of so much concern.*

The Run-off Flow-on Effects

The inshore waters of the Great Barrier Reef are subject to many human activities. The coastline adjacent to the Reef, while not densely populated, has a large number of cities and towns mostly situated on, or close to, the coast. These urban areas contribute significant nutrient contamination to the sea waters via increased tourism, sewage discharges, stormwater run-off, urban construction run-off, industrial waste discharge and shipping and port activities.

The large ports on the coast (Gladstone, Mackay, Townsville, and Cairns) must have their shipping channels dredged every year. Marinas berth thousands of small boats which use toxic paint on their hulls to stop fouling by algae and barnacles.

At the same time, many large ships, carrying varied cargoes, pass up and down the coast inside the Reef. Trawlers catch prawns, scallops and fish; game fishing boats catch marlin. Recreational and commercial fishermen catch barramundi in the creeks and estuaries near the coast, and coral trout and emperors on the reef.

Resorts are being built all along the coast and on the offshore islands. The tourists who stay at the resorts visit the main reef in large numbers and so pontoons are anchored on many reefs for them to use.

Then there are the human activities that cause the bottom to be stirred up 'unnaturally' and the water to become turbid, such as when trawls are dragged across the bottom, or breakwaters are constructed.

However, the major current concern comes via the rivers which discharge into the Reef waters—soils, excess fertiliser, pesticides and sewage from the farming and urban areas inland.

The nutrient problem

While coral needs some nutrients to let its associated plant cells grow and produce food, it seems to grow best in nutrient-poor conditions throughout the world. When nutrient levels are increased beyond what is normally present, a number of effects have been noticed. The coral skeleton becomes weaker and more likely to break up in storms. Algae grow quickly and cover up the coral, while the phytoplankton numbers increase thus making the water more cloudy and letting less light through for the corals. Thus a number of effects work together to make the coral less able to survive, and a coral reef may be slowly replaced by a seaweed-covered reef in dirty water.

The river-wastes problem

Of greatest importance to the general water quality of the Great Barrier Reef are the nutrients which are washed down the coastal rivers. While some rivers might contain sewage, the greater amount of nutrients in the rivers come from run-off from the land. While nutrients always run off land under natural conditions, modern agriculture has greatly increased the potential for larger amounts of phosphorus and nitrogen entering the waters of the Reef.

The Barron River, for example, drains a large area of country planted with sugar cane, tobacco and tropical fruits and grazed by large numbers of beef cattle.

All the large rivers along the coast drain similar areas where high levels of fertilisers are commonly used — the Burnett, Fitzroy, Pioneer, O'Connell, Proserpine, Burdekin, Herbert, Johnstone, Russell, Mulgrave,

Mossman rivers. In addition, soil erosion on these farming lands helps to carry down even more nutrients attached to soil particles.

The run-offs from these larger rivers, especially when they are in flood, do not dissipate as soon as they enter the sea, but travel well out into the waters of the Reef. The nutrient-rich waters from the Barron River, for example, may be affecting the reefs between Green Island and Low Isles.

The huge plume from the flooding Fitzroy River in January-February 1991 was detected as far north as Broad Sound and out in the Capricorn-Bunker Group islands to the southeast.

While we can quickly solve the sewage problem with better treatment plants, the problems of soil erosion and fertiliser run-off will be harder to master and take longer to control. The recent initiative of the Queensland Department of Primary Industries in establishing a broad-based advisory committee, consisting of scientists and on-the-land producers, to look at the effect of agricultural practices on coastal zone ecosystems is a step in the right direction.

The sewage problem

Sewage from treatment plant discharges may be a significant source of nutrient input into coastal waters. It comes from sewage plants on resorts

near the Reef or on islands on the Reef, from discharge from the large cities along the coast and from inland cities and towns via rivers which discharge into the sea near the Reef. It contains large quantities of both nitrogen and phosphorus, which the normal treatment plant does not remove. (The common 'secondary treatment' of most sewage plants is only aimed at lowering solids and bacterial contents and organic matter.)

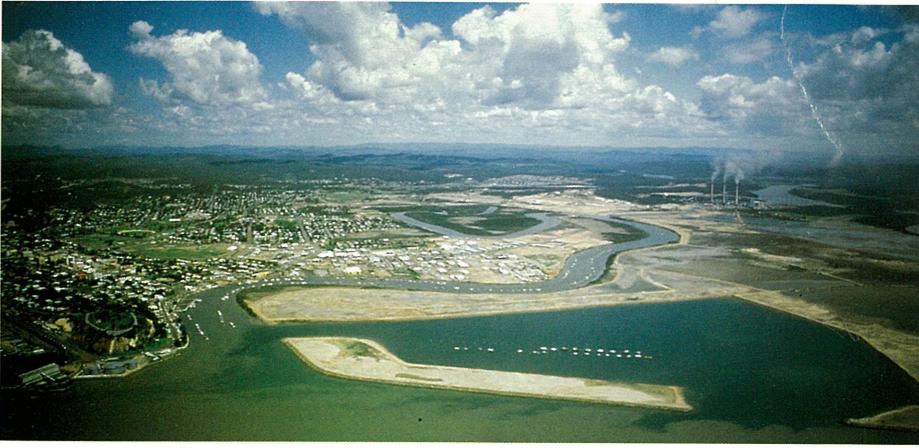
To control sewage problems, there are two courses of action. Either the nitrogen and phosphorus can be taken out before discharge — called nutrient removal or 'tertiary treatment' — or the sewage can be highly diluted so that its concentration will be so low as to have no effect.

It must be said that, up till now, proven cases of sewage damage to marine ecosystems in the Marine Park are few. The discharge of primary-treated effluent at Green Island has been suggested as the cause of extensive expansion of seagrass beds near the northern end of the cay, but further evidence is needed to prove the case. Also, adverse changes to the reef near the Hayman island sewage outfall, compared to control areas, have been demonstrated.

GBRMPA now requires all new proposals for sewage discharges into the Park to have nutrient removal treat-



The sediment plume of the flooding Burdekin River stretches kilometres into Reef waters.



Gladstone is an important urban centre in the Reef Region with a major refining industry and port.



Water quality research and monitoring are vital to the Reef's well-being.

ment and existing operations to install this by December 1995.

The sediment problem

Sediment patches, or plumes, are caused by rivers carrying large amounts of soil eroded from inland, and also by the dredging of shipping channels along the coast, trawling and construction activity. These patches present a double problem: the resulting turbidity and the resulting deposit on the bottom when the sediment settles out of the plume.

Apart from degrading the expectations that locals and visitors alike have for clear waters in the Marine Park, turbidity reduces the amount of sunlight piercing down through the water. Seagrass, corals and algae (seaweeds) all depend on sunlight to grow (which is why there are almost no corals growing deeper than 60 metres).

The effects of sedimentation are equally undesirable. It can smother whole coral reefs, seagrass beds and animals and plants that live on the bottom by covering them up with mud.

The urban construction problem

Urban construction, such as roadworks, residential development and vegetation clearance, are increasing sediment loads in the coastal zone. Sedimentation damage appears to have occurred on the Double Island fringing reef and this is attributed to coastal construction. The construction of the Cape Tribulation-Bloomfield Road — a poorly-constructed road — was suspected of causing damage to its adja-

cent fringing reefs, but continuing monitoring has not demonstrated significant impacts.

The stormwater run-off problem

Stormwater run-off contains significant concentrations of nutrients, sediments, metals, oils, synthetic organic chemicals and plastics, depending on the types of urban and industrial development present in an area.

Nutrients in stormwater flow may derive from garden fertiliser, animal feed lots, land disturbance from construction and pet animal wastes.

Trace metals in stormwater run-off can originate from vehicle emissions (particularly lead), fallout from metal wear and industrial activity. Synthetic chemicals include pesticides, solvents, paint residues and, in harbour areas, anti-fouling paint residues containing copper and organo-tin compounds.

The industrial wastes problem

Factories in the urban centres, while relatively few in number in the Marine Park region, are notorious sources of water pollution. As community awareness heightens, industries such as metal refineries, sugar mills, distilleries and meat works are taking more care about their effluents.

In the past we have had releases of ammonia wastes into coastal streams, as well as discharges of dunder (a by-product of alcohol distillation with an extremely high biochemical oxygen demand) and other waste chemicals, into coastal streams leading to heavy fish kills and mangrove destruction.

The shipping and port problem

Loading and unloading of materials in ports often leads to spillage into coastal waters. Dredging of harbour-access channels is another source of sediment and possible nutrient load off the major cities. Turbidity plumes arise both in the dredging operations and in the spoil-dumping operations offshore. The long-term dredging of the Platypus Channel, off Townsville, may have led to the degradation of the Magnetic Island fringing reefs, but this has not been verified. However, it is highly likely that a considerable reduction in seagrass beds in Cleveland Bay in the early 1970s was caused by the major dredging of that time and that some loss of mangrove forest on Magnetic Island occurred, although Cyclone Althea may have contributed to the loss also.

Adverse human impact from urban, agricultural, industrial and tourism sources on the Great Barrier Reef is growing. Impacts from channel dredging on the nearby Magnetic Island reefs, construction sediment on Double Island fringing reef, resort sewage impacts, and degradation of reefs off Cairns from river-borne agricultural run-off have been claimed, even though positive scientific proof is still lacking. However, residential and tourist populations on and near the Reef are increasing and, unfortunately, impacts from polluted water throughout the Marine Park may become more evident in the all-too-near future.

The fact that the Great Barrier Reef is the largest coral reef system in the world has overlain much of Australia's and Queensland's tourist promotion for many years.

Despite the fascination of reefs, the Great Barrier Reef is a difficult tourist destination. For most of its length the major and most spectacular reefs and clearest waters lie well offshore. Despite the obvious potential for increased reef tourism, access was a problem, so a number of operators experimented with high speed displacement hull vessels, hydrofoils and hovercrafts. The introduction, in 1982, of high-speed diesel-powered catamarans capable of carrying hundreds of people and travelling at over 25 knots made many reefs potentially accessible for day trips. As a consequence, between 1977 and 1987, figures for tourist operations showed dramatic increases. The number of operators increased more than ten fold, the number of passengers multiplied 35 fold to 450,000 with a quadrupling of the number of sites used regularly.

Environmental impacts

There are three consequent forms of environmental impact or threat which have to be addressed by conservation planning and management. The first impact is damage to structure; the second is damage to the natural processes; and the third involves the reduction in value of the natural amenity at any significant site.

Structural damage

As the coast becomes more heavily developed, the structural damage to marine ecosystems occurs particularly in the shallow coastal fringes where it takes the form of dredging, port development, coastal stabilisation, causeway construction, mariculture pond development and land reclamation.

Process damage

This involves indirect or accidental damage to ecosystems through alteration of some physical, chemical or biological factor. Physical factors generally concern changes to current patterns, levels of silt or flow of fresh water into the marine environment.

THE HUMAN

The impacts from tourism cannot be said to be potentially devastating for the Great Barrier Reef as a whole. There is not, as yet, high population density consistently along the 2300 kilometres of coast adjacent to the Marine Park; nor are the vast majority of the 2900 individual reefs, 300 cays and 600 continental islands directly affected by the resorts, marinas, jetties, pontoons, glass-bottom boats, and recreational activities on the 26 island resorts and the 20-plus regularly-visited reefs.

Yet, the 500,000 or more visitors to the Reef who are holidaying on its facilities for some 2.1 million visitor days a year, together with some estimates of at least ten per cent increase each year on these numbers in the future, are already putting great stress on small popular areas.

It has only been in the last decade that tourism to the Marine Park has become a major impactor on the Reef. In 1988, GBRMPA and the Queensland National Parks and Wildlife Service began discussions into what was to become the tourism strategy. This now consists of defining some areas as off-limits for tourist development, while subjecting available reefs to careful guidance on the nature of the amenity or activity allowable there. The object is to protect potentially vulnerable areas by defining for the tourist industry their capability and capacity for longer-term sustainable recreational use.

*The following article is extracted from papers by **Richard Kenchington**, who was the Assistant Executive Officer for Planning and Management with GBRMPA, and who is now Secretary for the coastal zone inquiry with the Resource Assessment Commission.*

Chemical problems relate to pollution where chemicals, such as those from pesticides or fertilisers in coastal run-off, distort or alter biological processes. Biological factors relate to damage to sensitive components of the ecosystem which affect the competitive or selective processes so necessary to diverse or distinctive communities.

Amenity maintenance impacts

To maintain the value of a site, in order to keep open the greatest options for people to use that site's essential quality and resources, we have to ensure management arrangements that avoid over-use and user-group conflicts and, in the long term, planning for future or potential use of that natural environment.

These three types of impacts may be interrelated. A structural impact which destroys or degrades a coral reef must affect the amenity value of that reef

for, say, reef viewing.

Tourist impacts

The impacts of tourism may be further divided into tourist activity impacts and tourist facility impacts.

The effects from tourist activity include intentional impacts arising from fishing or collecting — the removal of animals and their skeletal remains. They also include unintentional impacts to reefs or seabeds, such as reef boating, reef walking, snorkelling or diving.

The impacts from tourist facilities include the one-off effects from building or installing structures such as jetties, moorings, marinas, observatories, resorts and their supporting facilities, such as sewerage, power or water supply. Once the structure is complete there should be no more construction or installation impacts.

TOUCHES



Above, Centre and Bottom Right: Snorkellers, reef walkers and divers enjoy and learn about the Reef but they can unintentionally damage reefs.

Right: High speed catamarans and pontoons are allowing more people to enjoy and appreciate the Reef but impacts of facilities and activities must be monitored.

Tourist facility impacts also include recurrent effects associated with operation and accidents which arise in the course of use of such facilities and structures.

Decisions on the acceptability of these facility impacts should involve assessing the benefits of the project in terms of making the Reef available for those who would visit for recreation, education or contemplation, and comparing those benefits with the costs in terms of adverse impacts to the structure, processes and amenity of that area.

In practice, there are always some impacts from any level of recreational activity. These may be insignificant at low levels but, depending on the type and intensity of use as the tourism expands, a point is reached where management is needed to prevent or minimise damage.

The dilemma of environment management is to enable people to visit and appreciate such areas without destroying them or so changing them that the experience is degraded or trivialised.

This involves providing reasonable access to those who seek a close experience and understanding of the area, as well as for those who wish to go there but not necessarily as the primary focus of a vacation. Such management requires understanding of the ecology of the area and the social issues involved — the expectations, intended activities and important elements of the recreational experience of the various types of tourist-users to the area.

The tourism strategy being developed for the Marine Park will help divert pressures for development from the sensitive areas of the Park and adjacent coast to other less sensitive areas.

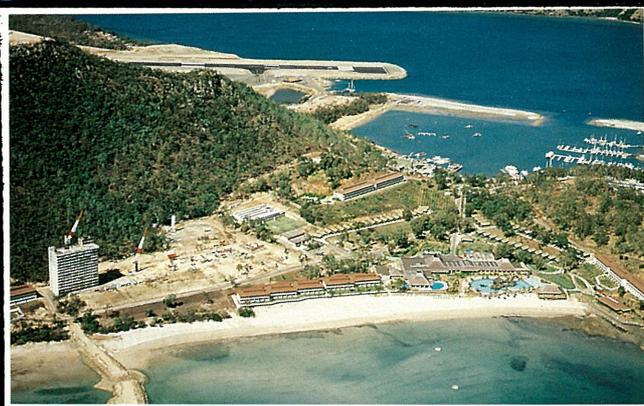
The tourism strategy will recognise the constraints and opportunities offered by the natural environment, the need for a spectrum of well-maintained recreational opportunities to attract visitors and, particularly, the need to provide for the social and recreational needs of the resident communities that attract the tourists.



Human Influence



Recreation



Tourism

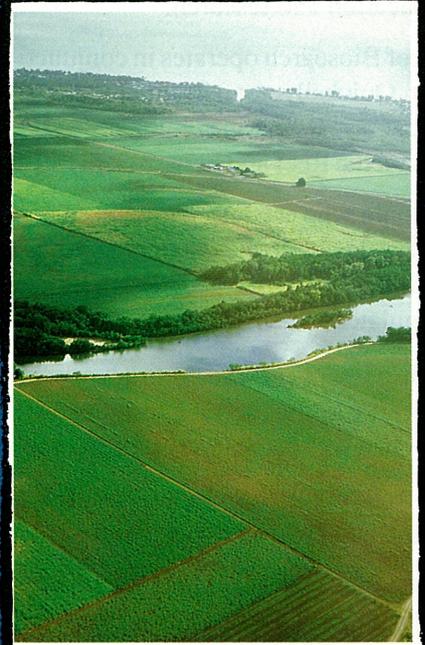


Shipping

ces on the Reef



Fishing



Agriculture



PROFILE

REEF BIOSEARCH

Reef Biosearch is a unique company that is genuinely and successfully able to define its activities in the oft-times conflicting areas of tourism, education and research.

Reef Biosearch operates in conjunction with the commercial tour operator, Quicksilver, in its outer reef and Low Isles daily services from Port Douglas. Its marine biologists on board these trips give illustrated talks about the Reef and its associated systems that are open to all passengers.

People who wish to know more can then enrol for various supervised activities after the catamarans reach their destinations. These include snorkelling tours and, if conditions permit at Low Isles, carefully-regulated walks among mangroves and reef areas.

The passengers who do so are provided with insights by scientists who do their day-to-day work in these specific areas and, because of this, receive insights that are very difficult to get normally into the local ecology and what has and might affect it. In a sense, these visitors are having guided tours around Biosearch's laboratory.

In return for the obvious mutual commercial advantages that the company gets from its intimate association with Quicksilver — and vice versa — its biologists have daily access to the Reef for research purposes.

This is not the only study area which the company engages upon, either. Underpinned by general funding from the Great Barrier Reef Marine Park Authority, it has used its 'natural laboratory' to study the effects of the floating pontoon and of seasonal changes on the bottom-dwelling communities in the areas.

One of its programs with the widest interest to GBRMPA — and to Quicksilver itself — is the study of what might be the effects on the local communities when Quicksilver moves its outer reef pontoons to new sites. Before and after studies for one such move in May 1990 are almost complete with a final report expected about September.

The research that Reef Biosearch's unique operations allow is vital. It is more than just a bridge between the language of science and the understanding of the public; it is also applicable to both sustainable Reef management plans by GBRMPA and to the long-term commercial planning by tourist operators. And that multi-purpose is rare indeed.



Visitors learn about the reef community on the guided snorkelling tour.



ACRS ANNUAL SCIENTIFIC MEETINGS

The Australian Coral Reef Society held its 1990 meeting, the best attended for several years, in Townsville in July. The two-day program was notable for the fact that the majority of presenters focused on research which addressed the conference's theme of the interactions between coastal catchments and reef environments.

This reflected the degree to which scientists and government are attempting to respond to the increasing human pressures on coral reef ecosystems.

The Minister for the Environment and Heritage, Mr Pat Comben, opened the conference and outlined the State government's new policy on coastal management which aimed to address the five issues of: conservation of estuarine wetlands; the Greenhouse effect; public ownership of beachfront land; balanced development; and education and awareness campaigns. It was hoped that this policy will include not only the coastal fringe, but also the total catchment area.

The ACRS held its 1991 scientific meeting at James Cook University in Townsville on 10-11 August. Under the theme 'climate and change on coral reefs', the meeting discussed current knowledge of natural change on reefs. Such a perspective is essential if scientists wish to evaluate the significance of human-generated disturbances.

ADOPTING A REEF

A continuing monitoring scheme, rather than the usual one-off expeditionary-style survey, by secondary school students on a reef island has set an important precedent for curricula.

Students from the Smithfield State High School in Cairns undertook a three-year study project on Green Island in order to gain insights into the problems, techniques and methods associated with environmental research and management in sensitive areas that have to cope with heavy tourism.

The following are extracts from the report of the scheme by the project coordinator, John McIntyre, a regional environmental projects organiser with the Queensland Education Department:

I felt that the project should meet two basic criteria. The first was that it had to be seen to have outcomes which would in some way benefit the reef environment — either from practical improvements or provision of information to assist in forming management decisions. The second was that the type of work had to take into account abilities and skills of the students involved and to be able to operate within the constraints of the school organisation as far as possible.

Getting started

Participation was open to all senior students, regardless of the nature of their course work, with the main selection criteria being motivation, diligence and trustworthiness. An advertisement for research assistants was placed in the school newsletter. Students had to complete a form outlining their reasons for applying and also provide information on personal skills and abilities which could contribute to the success of the project.

How it operated

The chosen venue — Green Island — involved a ferry trip and the then operators, Hayles Cairns Cruises, were approached for assistance, which they readily gave. Sponsorship, in the forms of hard- and software for surveying and a T-shirt 'uniform', also came from the Mulgrave Shire Council, the Marlin Coast Apex and the Education Department.

We finally selected 30 students, and formed five teams of six students. Each team visited the island four times per year.

The main task was the remote survey of all beach and water activities. The teams carried out these tasks for 15 minutes each hour for the duration of each six-hour visit. This 15-minute survey was followed by data collation, after which they had to rush back to their starting stations.

On return to school, the students had to spend time during lunch hours entering their data onto a database — a process that generally took about four hours for each trip.

In addition to the remote survey, they also designed and trialled a tourist expectation and profile survey, together with attempting to design self-guided trails through the forested area of the island.

The project ran for three years. The Q.NPWS made use of some information in the production of the current management plan review.

This type of concept need not be specifically related to the Reef, but could be expanded in many directions — beach profiling, fishing surveys, river monitoring, and the like. With so many schools situated along the Queensland coast, there is a huge potential to gather quality baseline data on our marine systems.



Student interest in and concern for their environment can provide useful data for management.

BIG INDUSTRY QUESTIONS

Bill Reed

A recent television ad, part of GBRMPA's extensive 'Fish for the Future' campaign epitomised the concern GBRMPA has for the effects all sorts of fishing activities are having on the resources of the Reef. It pointed out to TV audiences throughout the region that this year it was estimated about two-thirds of the total catch in the Reef region would be taken by recreational anglers. It encouraged anglers to think about the future of fishing and to take only 'today's needs'.

Other headlines also paint a picture of new energies being put into growing awareness for the need for fish-stock research and management. In the last few months, for example, local newspapers and industry magazines have highlighted:

- a campaign by many agencies including GBRMPA for long-term funding to study the effects of trawling and line fishing, and their combined effects on fish species
- a call by the Queensland Commercial Fishermen's Organisation for fewer trawlers, as well as for studies into: the role of nurseries; pollution affecting fish grounds and fish numbers; ballast water discharge; destruction of fisheries habitats; and environmental awareness
- the announcement by the Department of Primary Industries of a ten-year investigation into the effects of exploitation of fish stocks; and a five-year study into what effect fishing has on our turtle populations
- reviews by the Queensland Fish Management Authority into the Reef line fishery, the East Coast trawl fishery, the scallop fishery and the East Coast barramundi (inshore) fishery. The discussion paper for the last review includes a recommendation that professional gillnets not be set within 1000 metres either side or seaward of a creek or river estuary as a means of overcoming the problem of accidental netting of barramundi during the closed season.
- a just-completed study by GBRMPA into boat ramps adjacent to the Marine Park, as well as a preliminary survey into the effects of trawling.

Big business

The Queensland fishing fleet consists of more than 2000 vessels, of which about 950 are trawlers with a market value of about \$353 million and \$245 million respectively. About 1250 vessels operate in the Great Barrier Reef region and Torres Strait.

Fishermen earn about \$215 million from the Reef region catch, or almost 70 per cent of the Queensland catch value, and of this amount, some \$180 million is exported. At retail values, the Reef region represents \$429 million — almost three-quarters of the State's \$580 million a year. The local industry employs about 3800 master, trainee master and assistant master fishermen, almost two-thirds of the number for the State.

The flow-on effects to the economy of the local fishing industry are considerable. It is estimated that this stimulates about \$215 million worth of economic activity, which in turn creates something like 6700 extra jobs.

The commercial catch is of course distributed among hundreds of thousands of would-be fishermen.



Trawlers are a major part of the Reef region fishing fleet.



The scallop fishery has been the subject of a recent management review.

Even so, recreational fishing has continued to prove more important, in terms of monies invested and percentage of catch, than commercial fishing. It is estimated that more than 150 000 people go fishing in the area each year, with approximately 45 000 registered private boats from Gladstone to Cooktown — and these figures are growing about six per cent annually.

Understanding the implications

An overall picture of human impacts from all the various forms of fishing has not yet been formulated. Like other human impacts, there is more than face value in the study of any one fishing activity.

For example, we know that, for every trawl, many non-target species are brought to the surface and may be killed as by-products. It is reasonable to assume that the ecology of the bottom where trawling takes place is altered - just as clearing and ploughing a paddock alters the terrestrial balance - but whether this is detrimental to the ecosystem is yet to be determined. This is one of the major investigations of the research into the effects of trawling due to start late 1991. We know that turtles are caught (though most survive) in trawling nets in some areas at certain times of the year. Although 'turtle excluder devices' for nets have been developed, fishermen are looking to adjust their fishing practices to avoid this small accidental catch. We know, too, that such species as female mud crabs and dugong are



Line fishing is a major recreation as well as an important industry.

taken either by ignorance of the law or by accident. Until the interconnections of all the activities of fishing are analysed and understood, management planning to keep fishing on a renewable-resource footing will remain difficult, if only because of restricted research funds.

The need for this understanding was outlined by Tor Hundloe in his book, *Fisheries of the Great Barrier Reef*, published by GBRMPA. In his introduction, he states: 'The planner has to obtain an inventory of the biological and physical resources which comprise the area. He has to be able to comprehend these elements, for example fishes, corals, algae, as parts of an ecosystem. He next needs to obtain an inventory of the uses of the area; for example, how many fishing boats use the area, how many tourist facilities are in the area. He has to find out how important these uses are in economic terms and their role in meeting other social, conservation and cultural objectives...

'He has to estimate the effect of human activities on the ecology and, if adverse effects are occurring, he will need to consider using his zoning plan and/or regulations to ameliorate the problems. At the extreme he could prohibit a particular activity...

'These steps in formulating a management plan involve a process of interacting research and decision-making.'



Seaweek '91

FISH FOR THE FUTURE

When launching the annual *Seaweek* event this year, the Minister for Environment and Heritage, Mr Pat Comben, said he hoped that this successful annual activity week would once again encourage Queenslanders to consider the importance of the marine environment, especially responsible fishing.

This year's *Seaweek* theme, 'Fish for the Future', has been designed to highlight responsible fishing by recreational anglers, who take so much of the total fish numbers caught in the Marine Park each year, and for the need to protect our fish stocks through the control of pollution, wetland destruction and other flow-on human impacts.

Throughout the region, local community and school groups, companies, research organisations and agencies have held a wide range of participative activities — from seminars on future reef management to displays, exhibitions and school special projects and competitions.

Seaweek 91 is part of a wider strategy put forward by the Authority to raise public and scientific awareness of the dangers for fish and other creatures due to the welter of human impacts upon the Reef's limited resources. This campaign has included press and television advertisement aimed at over-catching by recreational anglers.

The annual event has especially encouraged young people to enjoy fishing under proper codes of behaviour, as well as informed the fishing community as to why fish stocks need to be conserved.

Each year, at least 2000 cargo ships use the protected shipping avenue of the Marine Park, let alone the many thousands of trips made by fishing fleets, yachts and boats into these waters.

Whatever their sizes, ships and boats are producers of effluent in the form of sewage and general garbage, which is all too often discharged into what too many people consider the endlessly diluting pool of the ocean.

In marinas all along the Park's coast, toxic chemicals from anti-fouling paints continue to seep into the waters. Although illegal, bilge and ballast tank waters containing oil are sometimes still pumped out at sea - causing considerable slicks in the case of large ships. Propellers brush and destroy a bit of coral here, a bit of coral there.

Yet these can be said to be almost just the communal garden damaging impacts, that are happening every day. On a different scale, are the potential dangers of the large ships, with their often potent cargoes, being involved in a collision, or running aground, and then breaking up or sinking.

Oil, however much it grabs the headlines, isn't the only potentially devastating spill-risk. Many ships ply other hazardous materials along the Great Barrier Reef every day — materials like aqua ammonia, caustic soda, sulphuric acid, ammonium nitrate and industrial alcohol — which could prove just as disastrous if ever an accidental collision, fire or explosion was to occur on board.

Nor are these doomsday predictions. Since 1770, the Reef has been a ships' graveyard, especially where it narrows so dramatically to only a few kilometres near its northern extremity. In the past five years alone, nine ships, including two oil tankers, have run aground and four others have collided with fishing boats.

Following are extracts from an article on the risks of oil spill recently prepared by **Steve Raaymakers**, a project officer for oil spills and sea dumping with GBRMPA.

PASSAGES AND POLLUTION

Cargo ships now carry hundreds of tonnes of fuel oil to feed their great churning propellers, and 200 of the ships that pass through the Reef each year are tankers, some carrying more than 10 000 tonnes of crude oil or oil products.

Should one of these ships be involved in an accident — such as grounding, collision or sinking — the effects on the Great Barrier Reef would be terrible.

Experience with oil spills on coral reefs in other parts of the world has shown that, in direct contact, many corals die very quickly because they are 'burnt' and their skins rupture. Those that do not die may suffer stress and, in the long term, become more susceptible to death from disease or be less successful in reproducing offspring. The abundances of marine creatures, such as crabs, shrimps and shellfish that live among the corals are also severely affected if covered with oil.

Of greater concern to the managers of the Reef region is the effect of oil on environments other than coral reefs, such as mangrove forests and seagrass beds — two very important nursery grounds for many of the prawns and fish we catch for our own tables and for export. An oil spill would also destroy the tourist industry in the area, as the unspoilt beaches of the island and coastal resorts were smothered in thick, black coatings.

REEFPLAN

The Queensland and Commonwealth governments have recognised the threat of a major oil spill in the region. They have ensured that shipping routes are well defined and that navigation aids are provided to help safe passage. It will soon be compulsory for potentially hazardous shipping to take on experienced professional pilots when moving through the waters of the Reef.

The Australian Maritime Safety





Oil discharge around jetties and ports over time may have significant impacts.

Authority and GBRMPA have now developed REEFPLAN, a contingency plan for oil spills in the region, in which the various responsibilities for local, state and federal bodies are clearly laid out. Under REEFPLAN, stockpiles of oil-spill response equipment are located in Brisbane and Townsville and regular exercises and training courses are held in order to maintain and continually upgrade states of readiness.

Unfortunately, despite the best contingency plans, the logistics and practicalities of response to a large oil spill will prove extremely difficult in practice in the Great Barrier Reef, where distances are so great and where virtually all areas are environmentally sensitive.

MORE THAN JUST ACCIDENTS

There are other, more insidious, chronic but less obvious and less publicised sources of oil pollution, and these in the long term may pose a more serious threat to the health of the Great Barrier Reef than isolated catastrophic events.

These sources are primarily operational discharges of oil and oily water not only from vessels, but also from terrestrial run-off.

Operational discharges are completely illegal and offenders can be fined up to \$250 000. Unfortunately, many irresponsible operators choose to ignore these laws and make no attempt to separate oil from their bilge water for on-board storage and proper disposal ashore before pumping out their bilges.

Terrestrial run-off is by no means as insignificant as it might seem at first sight. Rain water running over roads and other urban surfaces washes films of oil into drains and eventually into the sea. 'Backyard' mechanics also often dispose of waste oil into the same drains. In the United States, it has been reported that in one year approximately 350 million gallons of used oil were disposed of improperly in drains and waterways, representing 32 times the amount of oil spilled by the *Exxon Valdez* in Alaska. Crankcase oil drainings are reported to represent 40 per cent of the total oil pollution of US harbours and waterways.

Although such figures would be considerably less for Australia, terrestrial sources of oil pollution are a concern for the Great Barrier Reef, and must be expected to increase as urbanisation continues to creep along the Queensland coast.

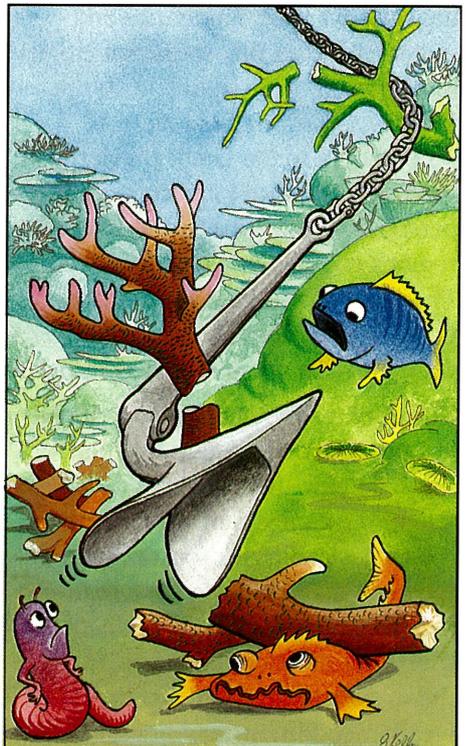
SECURING MOORINGS FOR THE REEF

In the popular visiting areas, the sheer numbers of anchors dropped each and every day constitute another major human impact.

The problem until now has been who is liable if, say, a mooring goes adrift while a boat is attached to it and the boat is damaged. This question has now been resolved with measures to limit to affordable levels GBRMPA's liability in the event of a mooring failure.

GBRMPA is now in the process of planning when and where moorings should be installed; what designs of moorings are best suited to particular conditions in the Park; how best they could be installed. Currently, the plan is to install them progressively as time and resources permit.

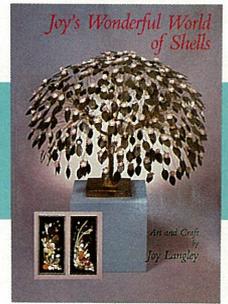
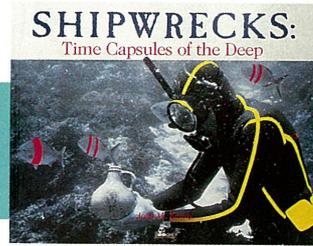
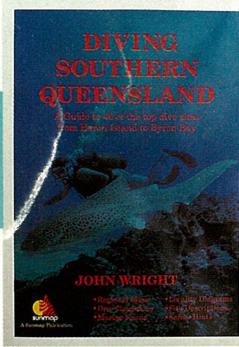
GBRMPA has also stepped up its efforts to create greater awareness through a media campaign centred on a Code of anchoring.



Code of Anchoring in the Reef Environment

- Anchor in sand away from coral.
- While fishing use a lightweight pick.
- When hauling in, motor toward the anchor to prevent dragging.
- Practise drift fishing over coral reefs.
- Tie up and fish from public moorings wherever possible.

REVIEWS



DIVING SOUTHERN QUEENSLAND

John Wright

Division of Information, Queensland
Department of Lands 1990
88 pages \$12.95

This book is a success. It is informative and descriptive; as I turned the last page I felt a strong urge to pack my gear and dive all of the 40 locations described. The author believes that, for its diversity of habitats and accessibility, the diving in southern Queensland is better than the Great Barrier Reef. His book is testimony to this belief.

John Wright has written a book on diving in southern Queensland. He has ignored state boundaries and included Byron Bay (northern NSW) in his review - the diving at Byron Bay is reputed in the book to be second only to the Great Barrier Reef. It's a notion I can support from personal diving experience. Other regions covered are: the Capricornia Region at the southern end of the GBR; Hervey Bay; the Sunshine Coast; Brisbane; and the Gold Coast.

The book is divided into five regions, each described in detail. Introductory notes include the addresses and telephone numbers of dive shops and the places and times for meetings of the local dive clubs. In each region there are a number of dive locations. These are detailed fully: how to drive there, sites to dive in different weather conditions and tides, safety hints, depths, and expected underwater visibility. Each location is rated according to its suitability for either beginner, intermediate, or advanced divers. There is a map for each location showing depths, the directions of currents, and the position of any wrecks. There are black and

white photos taken above the dive locations showing the markers used to line-up the site from a boat and also underwater photos of many locations. Blank pages are scattered throughout the text for the reader's own dive notes and there is a centre spread of colour underwater photographs.

My only criticism is that each dive location is given only a single rating, either beginner, intermediate, or advanced. Surely a dive location suitable for a beginner is also suitable for an advanced diver.

Many books and magazines about diving are written from a macho perspective of the sea - they teem with great depths, sharks, and seem to be solely thrill seeking. It is a welcome surprise that the whole variety of marine life is described in this book - Wright even writes colourfully and at great length about the echinoderms of Shag Rock. Wright stresses the need to conserve and manage and writes of damage inflicted by careless anchoring and excessive fishing and spearfishing. The maps highlight protected areas in many locations

Diving Southern Queensland has a functional format, it's cheap, lucid, and highly recommended.

Dr William Gladstone

SHIPWRECKS: TIME CAPSULES OF THE DEEP

Joan M. Kenny

Martin Educational 1989
56 pages \$6.95

Aimed at the teenage group, this book describes some of the older and more famous ships wrecked on the Australian coast. In describing their

voyages and their tragic ends, vital information about Australia's early European history is uncovered.

Among the oldest wreck is the *Vergulde Draeck* of the Dutch East India Company which struck disaster off the Western Australian coast and lay to rest its precious cargo, including chests of silver coins and ivory.

Also featured is the wreck of the *Batavia* with its rich cargo of jewels and coins and the saga of murder and greed by the survivors of the wreck. The Western Australian Maritime Museum is featured prominently with its magnificent work on the early traders.

His Majesty's Ship *Pandora*, wrecked on the Great Barrier Reef, forms the sequel to one of the greatest sea stories of all: the mutiny on the *Bounty*. The *Pandora* is the subject of the largest underwater excavations ever conducted.

The flagship of the First Fleet, HMS *Sirius* is the last wreck to be described and the role it played in our early convict history at Sydney Cove and Norfolk Island.

Despite the poor choice of the front cover, the book is wonderfully illustrated with early etchings, drawings and colour plates.

Ray Berkelmans

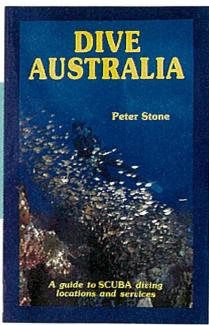
JOY'S WONDERFUL WORLD OF SHELLS

Joy Langley

Marlin Publications 1989
84 pages \$16.95

If you share the author's self-confessed obsession with the collection of beach shells, Joy Langley's book may inspire you to creativity.

This glossy book is written specifi-



cally for shell collectors who wish to use their beach finds creatively, using the natural colours and shapes to create pictures and ornaments.

It is essentially a hobby book, elaborately illustrated with colour plates of Joy's own creative masterpieces — shell flower pictures, decorated panels, and bird and fish ornaments.

The text, written in an informal style and illustrated extensively with line drawings, introduces the hobbyist to collecting do's and don'ts. The reader is taken through an anecdotal travelogue via the author's favourite Australian beaches, State-by-State, with descriptions of recommended collecting sites and shells to be found. Collectors in Queensland are, correctly, advised to consult with GBRMPA on shell-collecting permit requirements.

Following hints on shell sorting and cleaning, the bulk of the book is devoted to step-by-step instructions on the creation of shell flowers, fish and birds, encouraging the enthusiast to embark on a new and rewarding hobby. Joy Langley urges fellow shellers to find fulfilment in creating beautiful arrangements and pictures with shells, 'thus adding a richness and contentment to your life and a new sense of achievement'.

Bryony Barnett

DIVE AUSTRALIA **A guide to SCUBA diving** **locations and services**

Peter Stone

Oceans Enterprises 1990
288 pages \$19.95

Whether planning a dive safari of Australia, a few dives in your local area or just wanting to know a little

more about diving in this great watersports nation, the third and completely revised edition of Peter Stone's *Dive Australia* is a valuable and useful book.

Although designed primarily as a geographical directory of diving locations and services, guiding the reader on a circumnavigation of Australia and its inshore and oceanic islands, this compact yet comprehensive book also contains an informative section introducing the non-diver to this rapidly growing sport, an enlightening and increasingly important chapter on The Law and the Diver and an exhaustive treatment of Australian Historic Shipwrecks.

The main body of the book covers all Australian States and the Australian Islands in the Pacific and Indian Oceans, with a separate chapter on each detailing the main dive sites, dive shops and charter boats available plus marine park, boating and fisheries regulations and safety information. This is presented as a brief overview, with an extensive bibliography directing the reader to more detailed and specific dive site and diving information. There are dedicated chapters on the Great Barrier Reef and the Islands of Bass Strait, with that on the Great Barrier Reef providing extremely accurate and up-to-date information on the Great Barrier Reef Marine Park and the natural history of the Reef.

These chapters are conveniently complemented by six appendixes listing over five hundred dive clubs, diving associations, specialty services, wholesalers and importers and an index to dive locations covered in Australia's three main dive magazines - *Skindiving in Australia*,

Sportdiving and Scuba Diver.

Dive Australia is not a glossy publication, but with 100 black and white photographs, eight maps and diagrams and 288 pages literally jam-packed with the latest information it is an extremely practical and usable book that will not remain unopened on the coffee table. At only \$19.95 there is no excuse for it to be absent from any diving or travel library.

Steve Raaymakers

WHALES

A Survival Publication

Published by the Gould League of Victoria Inc, Revised 1988
24 pages \$4.00

Lately there has been an upsurge in our interest in whales, although they have always held a certain fascination for people.

This book provides a very simple and useful introduction to this fascinating topic, encouraging appreciation of these animals. Illustrations and diagrams show the common characteristics of whales and the differences between types of whales and how they can be recognised.

Whales are well known for the cohesive social bonds which exist within groups or 'pods' and communication is an essential aspect of their daily existence. Communication plus behaviours such as birth and growth, feeding and migration patterns are explained in simple terms.

A section about human interaction with whales describes how whales were hunted, almost to extinction in some cases, for a variety of products and also looks at the present day attitudes to whaling.

Some activities included in the book should help children better appreciate and understand the whales.

Children will also enjoy the whale stickers - drawings of 12 common whale species.

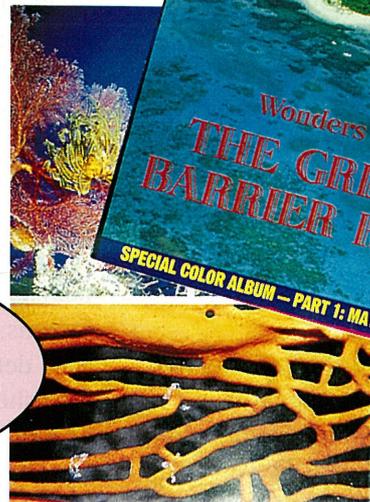
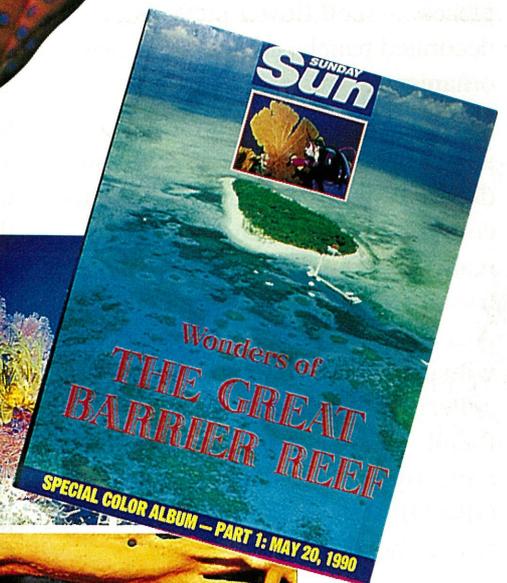
Mark Simmons

Current issues in the world's largest marine park

'You might think that protecting the Great Barrier Reef is easy, because all you have to do is stop people doing bad things. We wish it was that easy. Some of the issues that are discussed in this magazine describe why managing the Great Barrier Reef is a difficult task.'

EARLYBIRD OFFER

The first 200 orders will also receive the Sunday Sun colour supplements on the Great Barrier Reef.



ISSUES 60-page special edition on the Great Barrier Reef is available from the Great Barrier Reef Aquarium Shop, PO Box 1379, Townsville Qld 4810. Telephone (077) 81 8875

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ISSUES is a quarterly magazine for schools about current human and environmental issues. Published by Underwood Publications, PO Box 489, Bayswater Vic 3153. Telephone (03) 764 5460

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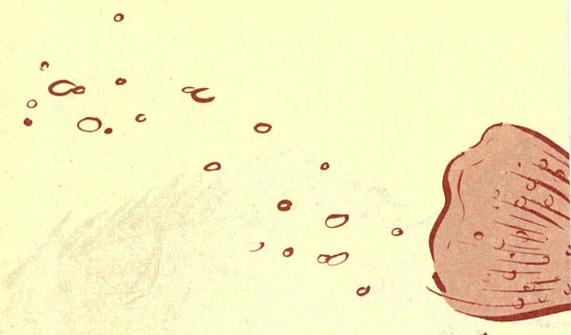
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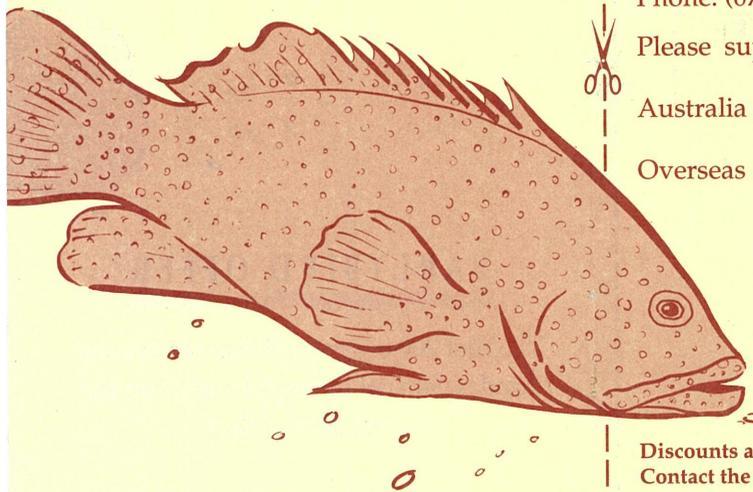
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