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REEF RESEARCH

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NEWSLETTER OF THE RESEARCH AND MONITORING SECTION

Editorial

The ethics of manipulative research is one issue which is being discussed widely these days. It is an issue on which many people have an opinion. Sometimes it may be necessary for scientists to perform research which may be termed 'manipulative' to assess impacts of change and to gain a greater understanding. The results of this research often provide managers with much needed information for decision-making processes. However, many questions need to be answered about this type of research, such as what degree of manipulation should be permitted.

Two articles in this issue of *Reef Research* discuss this very topic. Dominique Benzaken presents us with a brief outline of the approach the Great Barrier Reef Marine Park Authority is taking in regard to ethics of manipulative research. As you will read, an Interim Ethics Committee has been set up to oversee the assessment of permit applications received by the Authority. Professor Howard Choat comments on ethics in the framework of coastal and reef marine science in Australia. He discusses, amongst other things, the problems that may be caused to our graduates or younger scientists by the proposed changes to legislation and procedures regarding diving and research permits. Overall, it seems that many questions are still unanswered as to what constitutes manipulative research and what level of manipulation is 'reasonable'. It is good to see that the process to find answers to these questions has begun. ▶

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Editorial

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Leaving the topic of ethics for a while, Steve Raaymakers writes on the current status of oil spill research and development priorities and presents an update on oiled mangrove research being conducted by Dr Norm Duke. *What's Out There?* reports on an impact assessment study that looks at the impact the bund wall at Heron Island has on the coral communities in the area. The study has been carried out since 1993 by the Authority and the Department of Environment. Jon Brodie presents a summary of the temporal trends of nutrient and chlorophyll concentrations in the Great Barrier Reef lagoon.

Unfortunately this issue does not include a COTS COMMs article. The Authority's COTS staff have been very busy carrying out fine-scale surveys for most of this year and have been away for much of this time. Udo Engelhardt has promised a 'bumper' article for the next issue, so stay tuned.

Ed.

CRC Reef Research Centre UPDATE

by Chris Crossland

Given the intense scrutiny of CRC Reef's handful of manipulative research activities, by which we mean moving something rather than just observing it move, it may be useful at this time to highlight the concerns of scientists from other institutions. At the end of January 1997, Professor Howard Choat, Head of Marine Biology at James Cook University of North Queensland and also Leader of the Centre's Education Program, convened a meeting of scientists from many research institutions and universities, most of whom are recipients of Australian Research Council large grants. He highlighted to them that ethical issues surrounding research at the CRC Reef have far-reaching implications for all other scientists engaged in environmental research where components of the design are not confined to field observations. Unless the research community wakes up and gives active consideration to its work, many other projects are in potential jeopardy. What Howard said in his introduction concerns the big picture of the ethics of manipulative research in both marine and terrestrial environments. To broaden debate and to maintain the discussion clearly in the public arena, I am handing this column over to Professor Howard Choat for comment.

Coastal and reef marine science in Australia: infrastructure, access and ethics

Howard Choat

The next two years will be crucial for the long-term development of marine sciences in Australia. Government appears to be serious in setting about the establishment of a Marine Sciences Policy with implications for program and infrastructure funding in 1998 and beyond. Basic and applied research in both temperate and tropical marine environments share common needs for research infrastructure and cost-effective access to study sites. However, some components of research funding are increasingly being directed more explicitly to applied and strategic studies which meet the goals set by Government agencies and the private sector. No one argues against the need to set such goals, but the role of basic marine research in achieving them should be clearly articulated.

Of immediate concern are changes in procedures and legislation regarding research permits and diving activities. Lobbying by conservation groups and the need to comply with the Workplace Health and Safety Act are causing difficulties for field-based marine science. This is critical in areas that involve manipulative experiments and diving. For most of us these difficulties can be accommodated, although it may take more time and money. However, we can anticipate major problems for graduate students, younger scientists and in some circumstances overseas visitors. These groups must have guarantees that future access to the basic tools of research and marine environments will not be compromised. If we cannot provide such a guarantee then we have no strategic basis for the development of our discipline.

We need to consider the nature of submissions we might make to the development of a marine science and technology plan. What are the areas where unity is mandated, what areas require separate initiatives? To what degree should we seek common goals in the provision of research infrastructure and training? Is there a case for setting priorities for long-term program grants if these are offered by the Australian Research Council? To what extent should we seek uniform standards for diving and experimental research or is there a stronger case for regionalisation?

The meeting provided an opportunity to discuss ethics and the conduct of marine research. Scientific research in coastal and reef environments is an area in which Australia has attained internationally recognised standards of excellence. This work, involving basic and applied research, has been carried out both by tertiary institutions and government research establishments. It has provided a foundation for training and development of research skills in numerous cohorts of graduate students. Recent funding decisions by government have acknowledged this performance and provided for the establishment of a number of long-term, strategic research initiatives. An important element in these initiatives has been the opportunity to use rigorous research methodologies to resolve applied ecological questions and provide a framework for the predictive management of marine resources.

Field experimentation is an increasingly important aspect of the practice of marine science and of its education and training arm. The frequency of experimentation has increased as marine scientists have sought to improve their capacity to predict events. The scale of experiments has also increased as marine scientists are drawn into management issues. This has included the possibility of designing and executing manipulative experiments over a broader range of spatial and temporal scales than previously possible. Properly designed manipulative and mensurative experiments are now recognised by many managers as an important step in the decision-making process. Much of this has been made possible by the participation and support of the private sector.

This success has generated publicity and a greater awareness of scientific activities in marine research, which has in turn raised a number of questions. Some of these have been critical of both scientists and their procedures. They have focused largely on the ethics of manipulative experimentation and the collection of biological samples. The science community in general and the marine science community in particular needs to examine these issues. Ethics is used here in the sense of the principles of conduct governing a group, in this case marine scientists in execution of professional duties relating to field research.

In shallow water marine habitats experimental manipulations are often difficult to perform due to the substantial spatial and temporal variation which must be accommodated in the design. This is especially true of programs investigating the influence of human activities on biological processes at a number of scales. Opportunities for resolving such issues by manipulative experiments are limited and thus particularly valuable. However, field experimental procedures are now subject to increasing public and administrative scrutiny and demands for justification.

It is ironic that at a time when science and management recognise the need to resolve questions through good scientific practice, opposition to this is developing in the public arena. This opposition is presently focused on sampling and manipulative experiments in shallow tropical waters but will certainly extend to other areas.

Some of the opposition is simply a reaction from the public to scientists enjoying special privileges such as being permitted to take undersized fish. This is a common complaint and is usually resolved by public presentations and workshops. However, over the last year opposition has become more focused, with explicit targeting of sections of the scientific research community. Some conservation groups have formed alliances with political parties and developed this as a major issue both in the Senate and in the media. There is little doubt that the research community is seen as a high profile target.

There are two general categories of objection to research activities by these groups:

A) Objections of an ethical nature, which include:

- *physical destruction of habitats (especially corals);*
- *collecting and killing marine animals, or subjecting them to unnecessary suffering;*
- *overkill in sampling by the use of explosives and poisons which may result in chronic environmental damage.*

These objections reflect a moral disapproval of researchers' activities. The objectors are often not so much concerned with the frequency or scale of the activity but simply that it occurs at all.

B) Objections based on differences of opinion concerning scientific procedure. The tenor of the statements made is that:

- *much of the work carried out by scientists is redundant. The same type of experiment seems to be repeated many times. If an experiment has been done once what is the justification for repeating it except to keep scientists in work?*
- *in designing experiments scientists advocate disturbing protected areas which are meant to be refuges for exploited or endangered species. This should not be permitted as large areas of the environment are already disturbed and thus available for scientific studies;*
- *the questions scientists pose are self-evident. For example it is clear that fishing reduces the number of fish; it does not require an experiment to demonstrate this fact;*
- *scientists are not prepared to accept lessons from other research projects. For example Australians should be using information from examples of environmental degradation in other countries rather than damaging our own environments. A variant of this argument is that we should use existing data to run experiments as computer*

simulations rather than further disturbing the environment;

- *many research projects have too short a duration to yield useful results. Destruction can occur within hours but recovery can take decades. Scientists do not design projects which incorporate long-term monitoring;*
- *scientists exploit vulnerable elements of the population by taking large numbers of juveniles or sampling in habitat refuges. Research itself is pushing some species onto the endangered list.*

These criticisms reveal a certain degree of ignorance of scientific methodologies and the life history features of most marine organisms. The proponents of these critical views usually agree that some scientific research is required but argue that the present regime of manipulative experimentation is unnecessary and an example of scientific pork-barrelling. They say that scientists are advocating more experimental research as it keeps them employed. A more fundamental issue is the implication that we already have sufficient research information available. What is needed are more regulations, not more research.

At present most criticism of marine research is driven by some conservation groups aided by some sympathetic media contacts. Many conservation groups have been silent on the issue. The reaction of scientists is usually to point out the obvious:

- **that any damage inflicted is trivial compared to the scale of natural disturbance and prevailing mortality rates;**
- **the benefits will outweigh the costs of any disturbance that results from the research;**
- **the demographies and distribution patterns of most marine species make them unlikely candidates for the endangered species list.**

Unfortunately the relevant Ministers and their minders often feel that the path of least resistance is to assure the public that experimental manipulations will be curbed rather than explaining the benefits expected from best-practice research.

To date formal responses to these criticisms has been in the form of media statements by individual scientists, presentations at public meetings for particular interest groups and briefings of Ministers by small groups of scientists. The recent critical media campaigns have resulted in both State and Federal agencies calling for greater scrutiny of research or to set up independent committees to review permit applications for marine research.

In the near future ethical considerations arising from a wide variety of field research procedures are likely to be subject to a formal review. An appropriate agenda for the research community would be to:

- **communicate to the public the importance of good research practice;**
- **ensure that the research community is properly represented on any committees set up to evaluate applications for experimental research;**
- **develop the framework for a formal submission to the Australian Science and Technology Council (ASTEC) committee and the Australian Academy of Sciences on experimental ethics. This could be accomplished through a conference designed to discuss the question of experimental field manipulations especially in habitats which presently enjoy World Heritage status.**

Any such preparations must involve terrestrial biologists and those working with endangered species. Terrestrial biologists are dealing with genuinely endangered species and habitats fragmented to the threshold of long-term viability. Studies on some marine mammals and reptiles are also in this category. Any general statement on experimental procedures and ethics must accommodate the need for terrestrial biologists to carry out appropriately designed sampling and experimental programs. It should always be kept in mind that the most appropriate outcome of such a conference is improved communication between the research community, the public and other users of protected areas.

CRC Reef Research Centre

An unincorporated joint venture between:

Association of Marine Park Tourism Operators
Australian Institute of Marine Science
Great Barrier Reef Marine Park Authority
James Cook University
Department of Primary Industries

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Impact assessment of the Heron Island bund wall on coral communities

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When the reef rim of Heron Island's reef was breached in 1945 to allow boat access to the resort, a substantial change occurred to the hydrodynamics of the reef-flat. Water drained from the reef-flat during low tide; tidal currents formed through the hole in the reef rim carrying sediment from the reef-flat and cay; the sand spit on the north-west side of the cay moved to the south-west side and was almost completely eroded and the overall minimum water on the reef-flat appeared to drop significantly. A study examining the changes to the island's reef since 1989 has illustrated positive impacts on the reef's biota resulting from the re-design and re-building of the harbour's bund wall in 1993.

Photo 1. Heron Island harbour channel in 1979, prior to the construction of bund walls. Large erosion scars are evident as a result of water draining through the channel at low tide.

A history of change on Heron Island reef

Heron Island is a small coral cay in the southern Great Barrier Reef. The reef surrounding the cay forms a rim on the reef crest. As the tide level outside the reef falls to over a metre below the reef, the rim effectively moats the water on the reef-flat leaving a permanent cover of water over the reef-flat corals. The breaching of the rim in 1945 to allow boat access to the resort, and the dredging of a channel and small swing basin adjacent to the cay in 1966 caused dramatic changes to the hydrodynamics of the reef and resulted in considerable erosion (Flood 1984; GBRMPA, unpubl. photos) (photo 1) and a reduction in the reef-flat's biota (Oliver and Willis written communication to GBRMPA 1987).

In 1966 a one-metre high rubble wall was built along either side of the harbour channel in an attempt to reduce erosion. The rubble wall is believed to have caused an increase in the low tide level on the reef-flat. The walls were breached by cyclone Emily in April 1972. In the following 20 years continued attempts to remedy the effects of the breached rim failed. A series of cyclones exacerbated the problems and caused extensive sand loss from the island. Channel dredging and bund wall reconstruction were repeatedly undertaken with limited success.

In 1993–94, however, the bund wall was engineered properly for the first time and built as an interlocking series of concrete blocks, set on a concrete base to a height of 0.95 m above MLWS (mean low water springs). As a result of the construction of this new bund wall the minimum water level on the reef-flat was raised between 8 cm and 14 cm at sites close to the channel (Gourlay and Jell 1996) but no effect was detected more than 400 m from the harbour (Hacker and Gourlay, in press).

The monitoring project

The objective of this project, which commenced in 1993, was to monitor the response of the coral communities to the hydrodynamic and water level changes resulting from the bund wall development. The coral cover on the inner and outer reef-flat and on the lower reef-slope was measured and the number and size frequencies of coral colonies on the inner reef-flat recorded. These results were compared to data collected prior to the building of the bund wall. Coral cover was monitored along fixed transects at five sites on the inner reef-flat (A1, B1, C1, D1 and N1), five sites on the outer reef-flat (A2, B2, C2, D2 and N2) and four sites on the lower reef-slope (H1, H2, H3 and H4) (figure 1). A video transect method was used and the videos later analysed by a point-sampling method developed by the Australian Institute of Marine Science (Christie et al. 1996).

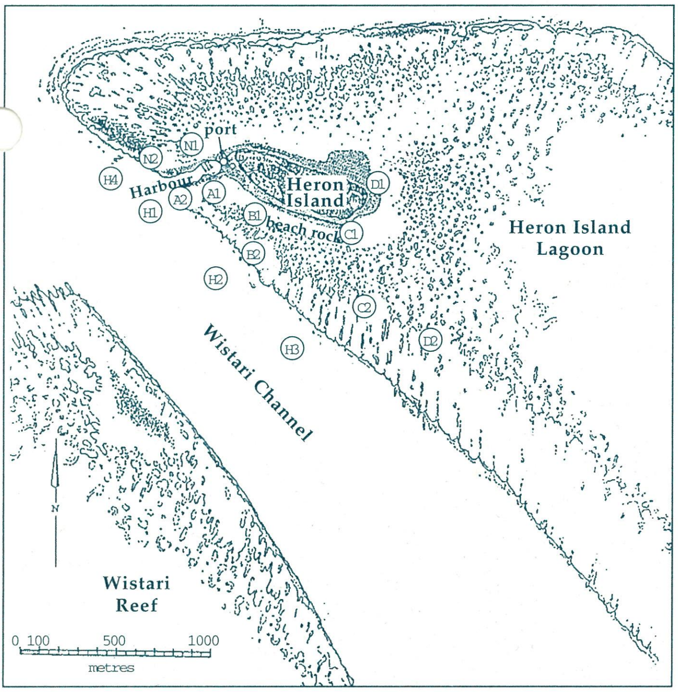

Figure 1. Heron Island and reef showing coral monitoring sites

Positive effects of the bund wall

The results indicated that on the outer reef-flat, coral cover increased at all sites from an overall 21.1% in 1993 to 32.5% in 1995. The highest increase was near the harbour at sites A2 and N2 (figure 2). Sites away from the harbour showed either no significant growth (B2 and C2) or only a marginal increase in coral cover (site D2). This pattern may be evidence of a positive impact of the harbour wall since October 1993, however no statistical analysis of these data has yet been undertaken and factors such as post-cyclone recovery may also be significant. The average rate of increase in coral cover on the outer reef-flat was 4.9% between 1993 and 1994 and 5.5% between 1994 and 1995. Most of the increase in coral cover could be attributed to growth of branching *Acropora* species and branching *Porites cylindrica* near the harbour. These data support the results of Hacker and Gourlay (in press) who found that individual colonies of *Acropora* north of the harbour grew up to 145 mm (linear extension) in the first two years following the bund wall reconstruction.

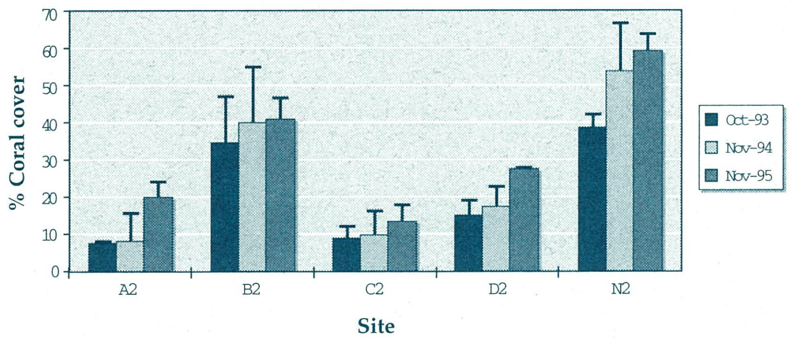

Figure 2. **Total hard coral cover at the outer reef-flat sites near the reef crest. Error bars indicate +/- SE**

On the inner reef-flat, adjacent to the cay, positive impacts of the bund wall are also evident, however these appear more variable between sites. A large increase at site A1 was detected (from 1.3 ± 0.7% in 1993 to 8.0 ± 1.4% in 1995), however, contrary to expectations, no significant change in percent coral cover occurred at site N1 north of the harbour suggesting that other processes limiting coral growth may be acting in this area. On the lower reef-slope a substantial increase in coral cover was detected across all sites and averaged 7.4% between 1993 and 1994 and 8.3% between 1994 and 1995. However, the similar pattern of increase across all sites from site H4 north of the harbour to H3, more than 1 km south of the harbour suggests that this growth cannot be attributed to the harbour bund wall development, but rather is likely the result of the reef recovering from the degradation caused by cyclone Fran in March 1992.

The positive effect of the bund wall is also evident from the growth morphology of large *Montipora* and *Acropora* colonies, especially north of the harbour. In many colonies, the margin around the colonies are 10–15 cm higher than the centre of the colonies (photo 2). These observations are consistent with a rise in the minimum low tide level of 14 cm north of the harbour which has been observed by Gourlay and Jell (1996) following the harbour wall development in 1994. The area north of the harbour is characterised by extensive stands of staghorn *Acropora* colonies and until 1994, these were interspersed with large open sandy areas. The open sandy areas are now closing as the margins of the staghorn colonies undergo rapid horizontal growth. This growth may be accelerated by the increase in the vertical growth limit of these corals.

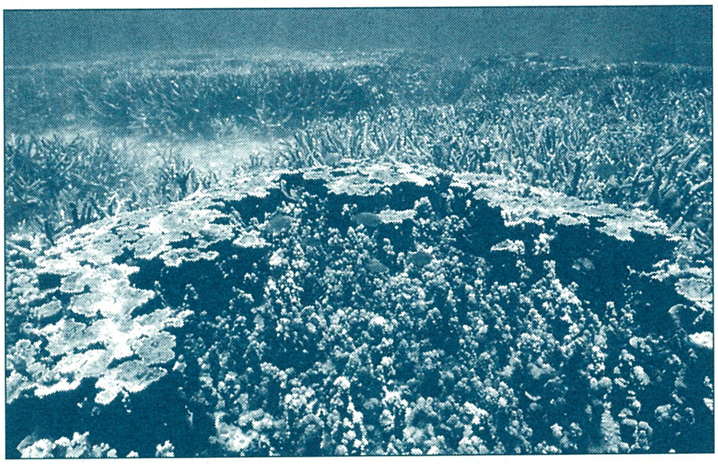

Photo 2. **Large *Montipora* sp. colony on the north side of the harbour. The outer margin of the colony has reached the new growth limit while the inner portion of the colony is still undergoing active vertical growth.**

South of the harbour, coral communities are dominated by slower growing *Porites* microatolls. These microatolls also show signs of vertical growth, which is evident by a thick lip of new growth around the perimeter of the colonies adjacent to their characteristically flat surface of dead skeleton. These flat surfaces most likely represent the vertical growth limit of the colonies prior to the 1994 bund wall reconstruction (photo 3). The height of this new growth lip of around 20 mm (as at November 1996) is consistent with growth rates reported in the literature for this species of around 9 mm per year (Veron 1993). A further interesting feature of the *Porites* microatolls immediately south of the harbour is that they also show a second platform in the centre of the colonies which is around 100 mm lower than the outer platform (Photo 3).

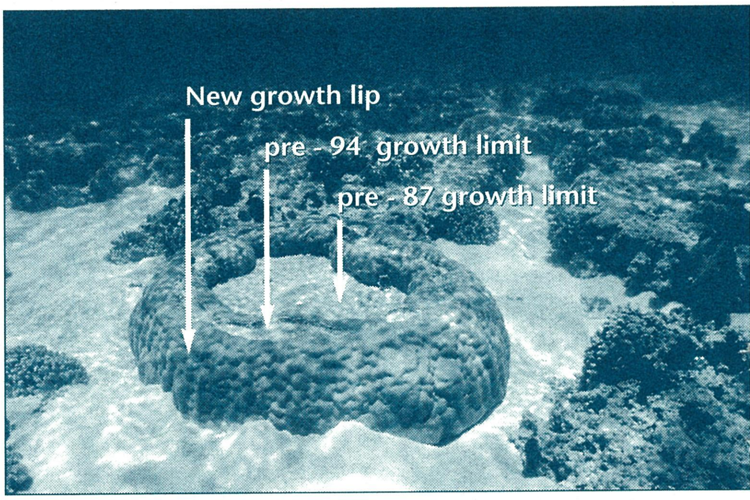

Photo 3. **Corals on the reef-flat south of the harbour are mainly composed of slower growing massive species such as *Porites*. Many colonies are showing signs of increased vertical growth, evident by a thick lip of new growth around the perimeter of the colonies. Photo taken at site A1 in November 1995. Note that this is probably the second vertical growth release, with the white space in the middle of the microatoll being the original vertical growth limit of the old colony.**

It is possible that these lower platforms in the middle of the microatolls represent the growth limit prior to 1987, when the height of the minimum low tide level inside the lagoon was raised (M. Prekker, pers. comm.). Fisk (1991) also attributes an increase in coral cover he observed between 1989 and 1990 to a raising of the minimum low tide levels. Adding further credence to this interpretation is a photo by Isobel Bennett, taken in 1950 in the vicinity of the current harbour, which shows no raised growth margins around a large *Porites* microatoll (photo 4). The lack of these raised growth margins on *Porites* microatolls away from the harbour is consistent with the results of tide monitoring since September 1993 which indicate that the effects of the increase in minimum low tide levels is reduced to almost zero approximately 400 m away from the harbour (Hacker and Gourlay, in press).

Photo 4.

There are no raised margins on this *Porites* microatoll in the vicinity of the present harbour back in 1950 (photo courtesy of Isobel Bennett). See text for details.

A positive effect of the 1993 bund wall development may also be evident in the number of coral colonies on the inner reef-flat south of the harbour. There was a steady decline in the number of colonies between 1989 and 1994 across all sites (figure 3). The trend levelled out in 1995 and 1996 at sites B1, C1 and D1, but was reversed at site A1 in these last two years. This is indicative of a possible positive effect of the harbour bund wall on the number of coral colonies, mainly through coral recruitment and growth of fragments of branching corals in the 0–25 cm^2 size class (figure 4).

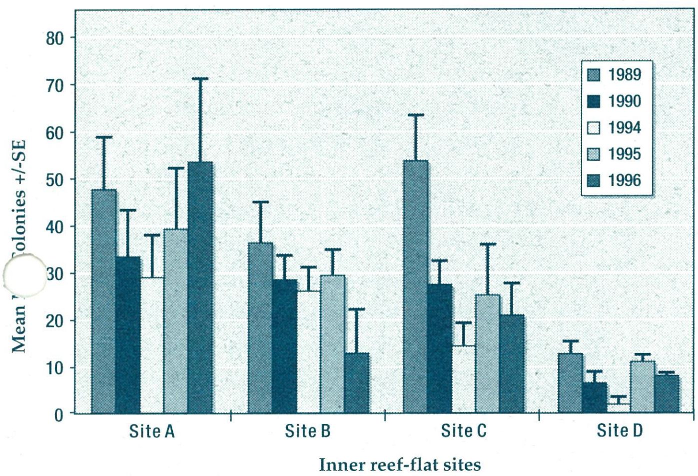

Figure 3. Mean number of corals in a 50 cm belt transect at each site on the inner reef-flat between 1989 and 1996

Overall, coral communities on the Heron Island reef-flat appear to have responded positively to increased minimum tide levels brought about by the re-construction of bund walls along the harbour channel. Photographs of the sites show increased vertical growth, and both coral cover and numbers of colonies have increased close to the harbour due to the raised lagoonal tidal level. Such results have provided valuable information on effects of bund wall construction near degraded sites and an insight into the ability and processes of reefs to recover from human impacts.

Acknowledgements

This study is part of a long-term video monitoring program undertaken jointly by the Queensland Department of Environment and the Great Barrier Reef Marine Park Authority. P&O Resorts Pty Ltd have funded the program and generously provided transport and meals at Heron Island for all staff involved in the program since its inception.

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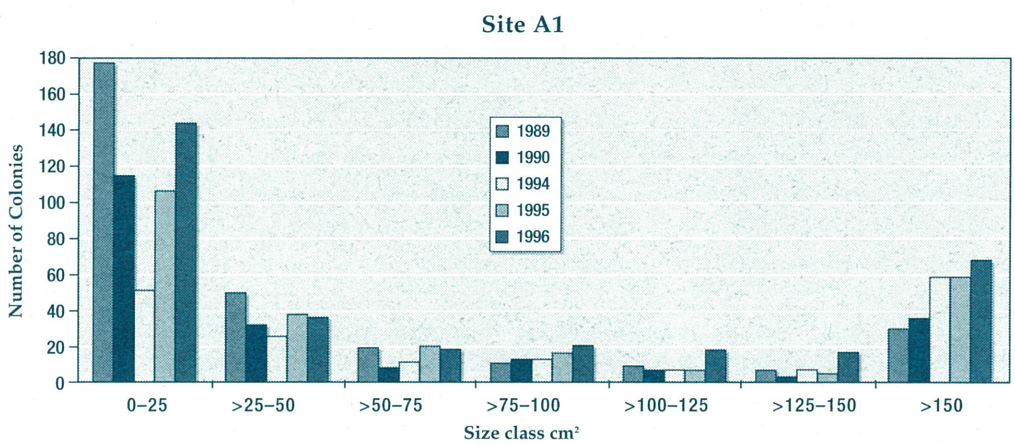
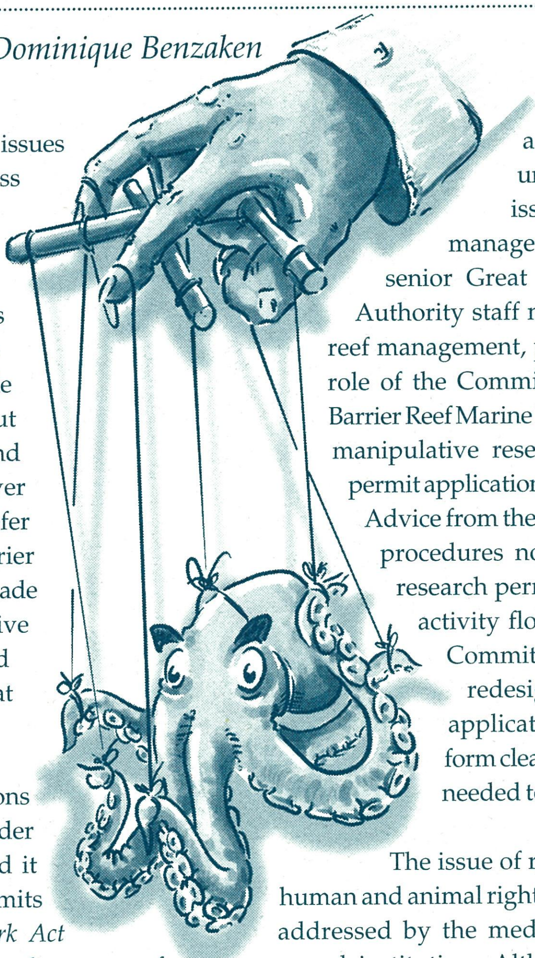


Figure 4.

Size frequency distribution of corals in a 50 cm belt transect at site A1

ETHICS OF MANIPULATIVE RESEARCH

Dominique Benzaken



Community concerns have raised issues concerning the appropriateness and conduct of manipulative research in the Great Barrier Reef World Heritage Area. A project to investigate anchor damage in the Whitsunday Islands was to be funded by the Cooperative Research Centre for Ecologically Sustainable Development of the Great Barrier Reef but did not go ahead. Recent controversy and debate in the media and in Parliament over the Effects of Line Fishing Experiment (refer to 'Fishing: The effects on the Great Barrier Reef?' *Reef Research* December 1996) have made consideration of the ethics of manipulative research in the Great Barrier Reef World Heritage Area a priority issue for the Great Barrier Reef Marine Park Authority.

Currently research is allowed in all Sections of the Great Barrier Reef Marine Park, under the provisions of zoning plans, provided it conforms to regulations for granting permits under the *Great Barrier Reef Marine Park Act 1975*. In the case of manipulative research, extent of environmental damage, loss of amenity and feasible alternatives are some of the criteria used by delegates in granting permits. The Great Barrier Reef Marine Park Authority and the Queensland Department of Environment jointly assess research permit applications. Permits have been refused where the design and procedures were considered unreasonable. In most cases research permit applications are for the conduct of non-manipulative research as defined in Great Barrier Reef Marine Park Authority zoning plans.

In response to community concerns, the Great Barrier Reef Marine Park Authority has developed an interim strategy to ensure that the current procedures for permit assessment are more transparent and accountable. The establishment of an Interim Ethics Committee is a major component of this strategy.

The Committee is locally based and consists of an independent chair, an expert in research design not involved in reef research, an expert in environmental ethics, a person with knowledge and understanding of community issues associated with the management of natural areas and a senior Great Barrier Reef Marine Park Authority staff member with knowledge of reef management, policy and procedures. The role of the Committee is to advise the Great Barrier Reef Marine Park Authority as to whether manipulative research proposed in referred permit applications constitutes reasonable use. Advice from the Committee will enhance the procedures now operating for assessing research permit applications. Part of the activity flowing from the work of the Committee includes advice on the redesign of the research permit application form to ensure that the form clearly identifies the information needed to make a speedy assessment.

The issue of research ethics in relation to human and animal rights has been comprehensively addressed by the medical professions and other research institutions. Although the theoretical aspects of environmental ethics have been researched and discussed in the literature, research and environmental management agencies in Australia and overseas have not to date developed ethical policies and practices in relation to ecosystems and biodiversity.

The Authority has also commenced discussions with the Federation of Australian Scientific and Technological Societies, the Australian Academy of Sciences and the Australian Science and Technology Council with the view to developing generic policy guidelines for manipulative research in World Heritage and protected areas. The Great Barrier Reef Marine Park Authority has put forward a proposal for a national conference to facilitate debate and discussion of those issues and to assist in the development of generic guidelines.

For further information please contact Dominique Benzaken at the Great Barrier Reef Marine Park Authority, telephone +61 77 500 715

Nutrient and chlorophyll concentrations in the Great Barrier Reef lagoon
TEMPORAL TRENDS

Jon Brodie

To determine the impact of human activities, particularly land-use practices, on the water quality of the Great Barrier Reef shelf, it is essential to define naturally occurring concentrations of nutrients and particulates in Great Barrier Reef waters. Natural variability, the sources of nutrients and sediments and the in situ processes whereby nutrients affect water quality and Great Barrier Reef ecosystems also need to be understood.

As part of the oceanographic studies carried out by the Australian Institute of Marine Science (AIMS) within the Great Barrier Reef region over the last 20 years, a large body of nutrient and other water quality related information has been collected. While most of these data were not collected explicitly to address water quality issues, they have the largest temporal and spatial coverage of any data set and the advantage of having been collected and analysed in a consistent manner. The trends summarised in this article are derived from these data, which were collected mostly by the AIMS Biological Oceanography Group between 1976 and the present. In addition, chlorophyll data from the Great Barrier Reef Marine Park Authority's long-term chlorophyll monitoring network (to be published as a Research Publication shortly – Steven et al., in press) is also included.

Much of the raw data have been published in data reports. Miles Furnas and co-workers at AIMS and the Great Barrier Reef Marine Park Authority (GBRMPA) have now summarised and analysed the data and two recent papers summarise spatial and temporal trends in the data (Furnas and Brodie 1996; Brodie et al., in press). Details of sampling procedures and chemical analysis methods are given in the specific reports. With minor changes, sampling practices, sample handling and analytical methods have been stable throughout the period. The figures in this article have been adapted from the papers cited above.

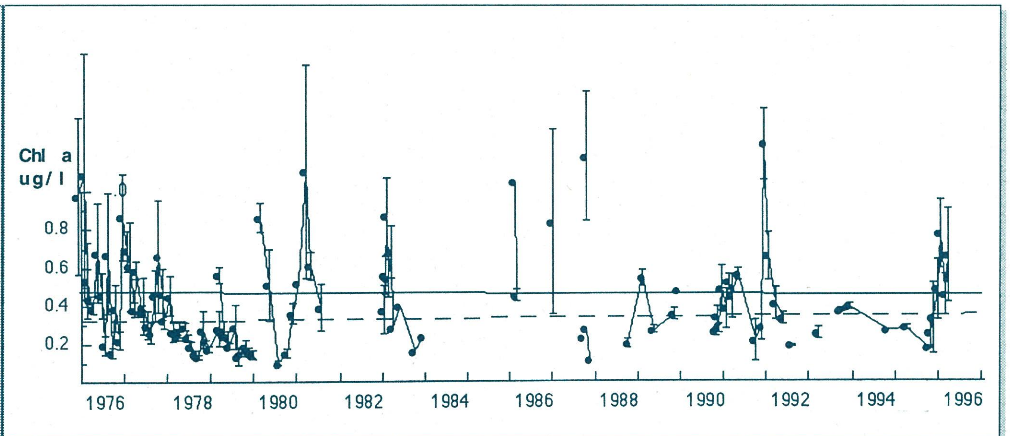
Chlorophyll

Figure 1 summarises a large number of measured chlorophyll concentrations in the central Great Barrier Reef lagoon from Dunk Island to Cape Bowling Green (18° – 19°30'S) between December 1975 and March 1996. All stations selected for this figure were in waters of depth from 20–40 m. Points represent means of monthly blocks (pre-1980) or individual cruises (post-1980). The solid line is a linear regression of the summer mean concentrations (October–April) and the dashed line is of the winter mean concentrations (May–September).

Figure 1. Mean water column chlorophyll concentrations measured in the central Great Barrier Reef lagoon (18°S – 19°30'S) between December 1975 and March 1996 (see text for details)

– summer cumulative mean,

-- winter cumulative mean



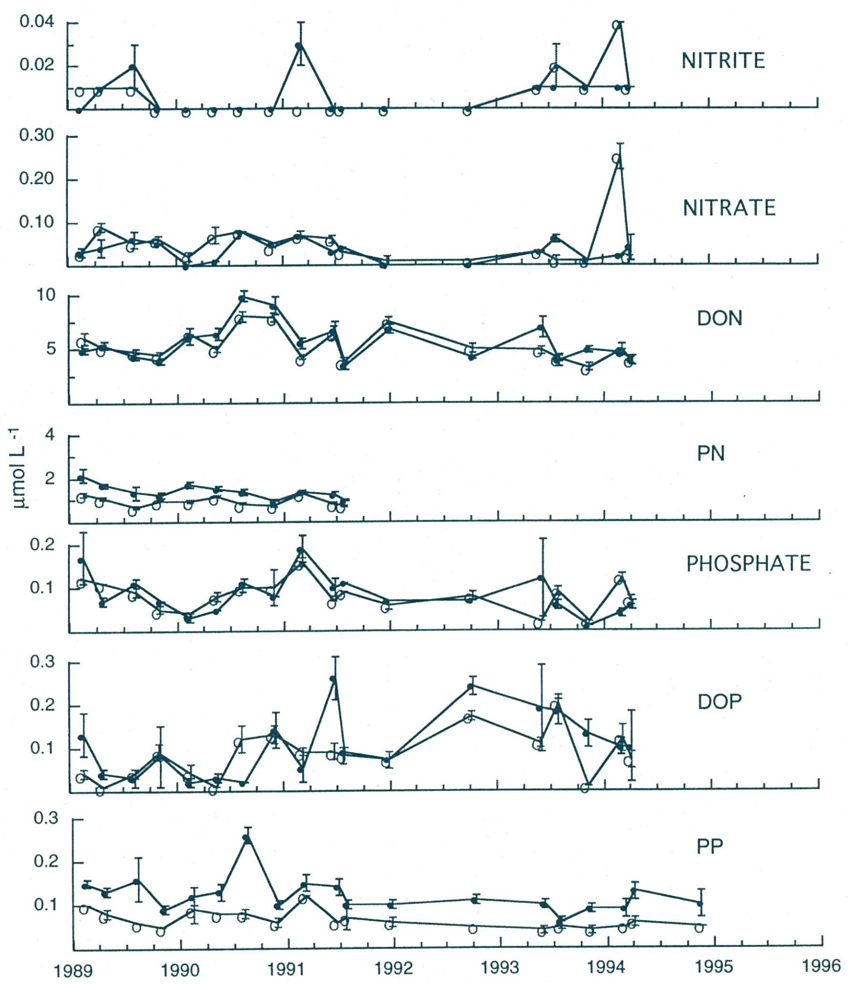
Mean concentrations shown in figure 1 vary over a wide range from ~0.1 to 1.3 µg/L. Stations directly affected by cyclonic disturbance (flood plumes, extensive sediment resuspension) were excluded from the analysis. These have measured chlorophyll concentrations of up to 20 µg/L (Brodie and Furnas 1996). Seasonal patterns in the data are apparent with the long-term mean summer value of 0.45 µg/L significantly different to the winter value of 0.33 µg/L. The seasonal regressions against time, shown in the figure, yield slopes not significantly different from zero. This analysis does not then support a case for an increase in chlorophyll concentrations (e.g. Bell 1992) and hence phytoplankton biomass, in the outer water of the central Great Barrier Reef over the last 20 years. The means are lower than, but close to, values of chlorophyll (0.4–1.0 µg/L) associated with eutrophication and reduced coral growth in Barbados (Tomascik and Sanders 1985). The mean concentrations are approximately twice those measured (< 0.2 µg/L) in the adjacent Coral Sea in the East Australian Current.

Nutrients

Figures 2 and 3 summarise a large number of dissolved and particulate nutrient species, salinity and suspended solid concentrations from lagoon waters off Cairns in the period 1989 to 1995. This sector is one of the most consistently sampled sectors by the AIMS Biological Oceanography Group. The results plotted on the figure are depth-weighted mean water column concentrations of stations in zero to 100 m depths and exclude sampling immediately following cyclones (see Brodie and Furnas 1996). The data set is weighted toward mid- and outer-shelf sampling stations as these have been sampled more intensively than inshore areas.

The concentrations show distinct seasonal (between cruise) variability, particularly for dissolved inorganic species, with particulate and dissolved organic nitrogen the most stable parameters. Concentrations over this relatively short time series lack any overall temporal trend. Some peaks are clearly related to run-off events, as indicated by lowered salinity, notably in early 1991. Nitrate and suspended sediment concentrations are considerably below (almost one order of magnitude) those measured along the Barbados eutrophication gradient. Mean phosphate concentrations, however, are of similar order.

Figure 2. Changes in the concentrations of nitrogen and phosphorus species in coastal (•) and offshore (o) areas in the Cairns region between 1989 and 1995



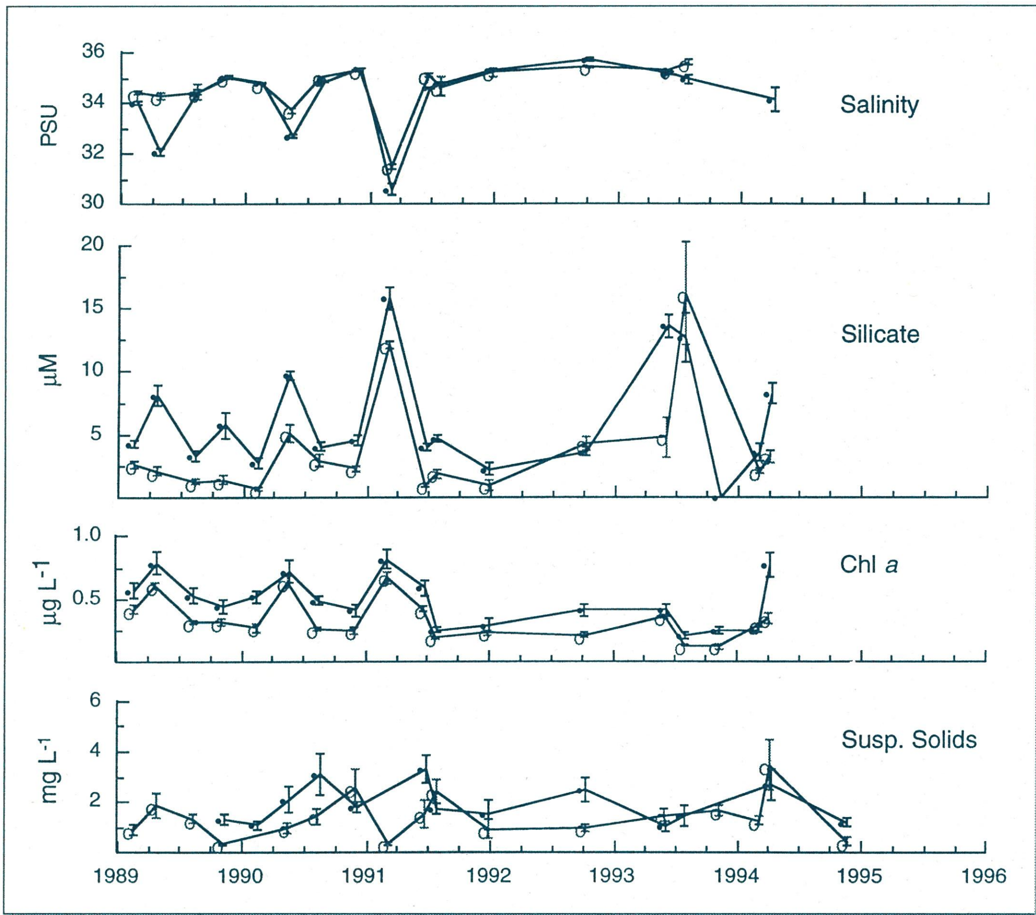


Figure 3. Changes in the concentrations of water quality parameters in coastal (•) and offshore (o) areas in the Cairns region between 1989 and 1995 (PSU equivalent to ‰)

Discussion

A chlorophyll record covering the last 20 years allows us to make some conclusions regarding trends. However, the most significant periods when possible anthropogenic activities on the coast may have affected the nutrient status of the Great Barrier Reef (catchment clearing, 1880–1980; fertiliser use, 1950–present) are largely not covered. Information on trends in riverine sediment and nutrient supply to the Great Barrier Reef as interpreted from sediment and coral cores may help fill this gap in the future.

References

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Brodie, J.E. and Furnas, M.J. 1996, Cyclones, river flood plumes and natural water quality extremes in the central Great Barrier Reef, pp. 367–374, in HM Hunter, AG Eyles and GE Rayment (eds), *Downstream Effects of Land Use*, A National Conference on Downstream Effects of Land Use, held in Rockhampton, Queensland, Australia, 26–28 April 1995, Dept of Natural Resources, Queensland.

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Steven, A.D.L., Trott, L., Pantus, F. and Brooks, D. in press, Great Barrier Reef Water Quality Monitoring Network: Status Report 1, Research Publication Series, Great Barrier Reef Marine Park Authority, Townsville.

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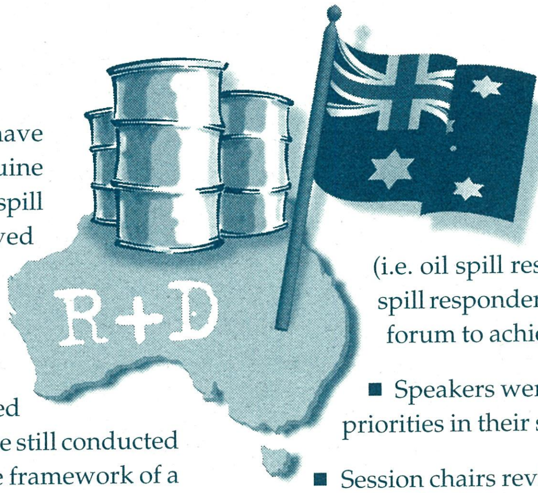
with Steve Raaymakers

In this edition of Slick Talk we review the current status of international oil spill research and development priorities and also the International Maritime Organization's research and development database.

We also provide a short update on research being conducted on oiled mangroves in the southern Great Barrier Reef region.

Research and Development Forum Highlights Priorities



For several years now I have continued to argue that genuine improvements in Australia's oil spill response capability can only be achieved through a concerted, ongoing research and development (R&D) effort. While the number of oil spill R&D projects has increased in Australia in recent years (see, for example, the item on oiled mangroves on page 16), these projects are still conducted on a piecemeal, ad hoc basis without the framework of a formal, national oil spill R&D strategy with clearly defined priorities, directions, funding and management structures.

This is in contrast to other countries, such as the United States, Canada and some European countries, where defined and directed R&D programs form an integral component of national oil spill arrangements.

The international direction of oil spill R&D was highlighted at the Second International Oil Spill Research and Development Forum held by the International Maritime Organization in London in May 1995.

A major objective of this forum was to debate and identify R&D priorities as perceived by both suppliers (i.e. oil spill researchers) and users (i.e. oil spill responders). The approach used at the forum to achieve this was as follows:

- Speakers were asked to identify R&D priorities in their specialty areas.
- Session chairs reviewed submitted papers and consolidated R&D needs within their session specialities.
- Summaries from the session chairs were consolidated again to provide a discussion document for debate at the forum.
- Priorities identified in the discussion document were debated and additional items added.
- Session chairs then prioritised R&D needs in their session specialities in light of the debate and the top two priorities from each were entered onto a ballot sheet.

- After further debate of the topics on the ballot sheet, and addition of further topics, all delegates were asked to choose 10 priorities from the 27 listed on the ballot sheet.

- All R&D needs were prioritised according to total votes received.

In the end result, the following five topics were identified as having highest priority (in order):

- effectiveness of different response strategies

- natural recovery of shorelines

- on-site criteria for bioremediation use

- standards for dispersant toxicity/efficacy

- criteria for inshore dispersant use

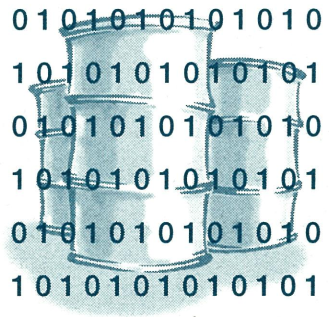
It is encouraging to note that in Australia, despite the lack of a similar, formal definition of oil spill R&D needs and priorities, some research is currently being conducted on some aspects of all of the above.

It is interesting and worrying to note that despite widespread recognition within the oil spill 'community' that prevention is better than cure, R&D of oil spill *prevention* technology was accorded one of the lowest priorities by the forum. One possible explanation is that the oil spill R&D community is dominated by chemists, biologists and oceanographers, while oil spill prevention is the domain of engineers, naval architects and mariners. Also, the forum was attended by many from the oil spill *response* community, whose focus is obviously on dealing with spills after they have occurred. This highlights the vital need to ensure that R&D priorities are management driven rather than researcher or just responder driven.

It would be interesting to hold a similar exercise in Australia, to develop a locally relevant set of R&D needs and priorities, and assess whether this differs significantly from the international scene.

Further details can be obtained from *Spill Science & Technology Bulletin Vol. 2 No. 4 1995*

R&D Database a Useful Resource



In conjunction with the Second International Oil Spill Research and Development Forum, the International Maritime Organization released the Second International Oil Spill R&D Abstract Database.

This database was developed using FileMaker Pro 2.1 software for Windows. The contents are retrievable using a number of search fields. These include:

- research category
- keywords
- name of R&D sponsors and research organisations
- funding arrangements, and
- completion dates.

In 1995 the database contained approximately 250 oil spill R&D projects from around the world. The International Maritime Organization proposed to publish an updated edition of the database in the last quarter of 1996.

Given the current general lack of locally relevant oil spill R&D in Australia, which creates an undesirable dependence on overseas work, the database provides a useful resource for Australian oil spill researchers and responders. Australian oil spill researchers should also consider entering their projects onto the database, to ensure availability of results to overseas workers and to identify collaborative opportunities.

All queries should be directed to:

Marine Pollution Information Officer
Oil Pollution Coordination Centre
International Maritime Organization
4 Albert Embankment
London SE1 7SR
Ph. +44 171 587 3248
Fax +44 171 587 3261

In addition, the IMO has recently made moves to go on-line, with an Internet site located at *http://www.imo.org*. It is not clear at this stage whether or not the International Oil Spill R&D Abstract Database will be accessible through the net.

Duke's Mangrove Oiling on Track

In Slick Talk #16 (*Reef Research* March 1996), we reported on the proposed oiled mangrove research to be conducted by Dr Norm Duke of the Cooperative Research Centre for Ecologically Sustainable Development of the Great Barrier Reef/Australian Institute of Marine Science, with funding from the Energy Research and Development Corporation (ERDC) and the Australian Petroleum Production and Exploration Association (APPEA). In January 1997 Duke reported that work is well under way and running smoothly.

A primary objective of Duke's research is to assess the effects of both oil and chemical dispersants on Australian mangroves. This assessment will provide much needed data on the Australian situation and help to alleviate the current dependence on overseas experience. Mangroves have been identified as one of the coastal resources most vulnerable to oil spill impacts, and this is especially the case along the Great Barrier Reef coastline where mangroves constitute a dominant part of the coastal ecology around many port areas.

An undertaking of Duke's mangrove research was to prevent harmful impacts of the experimental oiling on valuable mangrove areas. To achieve this a mangrove site consisting mainly of *Rhizophora stylosa* was identified at Gladstone Harbour. The vegetation had been approved for removal already as part of port development works.

Controlled and contained oiling, plus treatment with dispersed oil, was carried out in October 1996 under stringent supervision by the Queensland Departments of Primary Industries, Environment and Transport, the Gladstone Port Authority, the Great Barrier Reef Marine Park Authority and others. Control sites with no treatments have also been established.

Hydrocarbon and biological sampling was commenced in July 1996 to provide a pre-treatment baseline. The sampling has been conducted regularly since the oiling and will continue until the site is no longer available as port development works proceed (about two years).

The data gathered so far is still being analysed and assessed, and will provide an extremely useful information base to assist oil spill responders once fully reported at the end of the project. The site at Gladstone will provide data of general relevance to northern Australia. However, it should be noted that Gladstone is located in the sub-tropics and caution would need to be exercised in extrapolating the data to mangrove ecosystems located in the northern tropics of Cape York Peninsula, the Northern Territory and northern Western Australia.

In a complimentary project, Duke is also conducting an assessment of mangrove impacts at real-spill sites, including northern tropical sites such as the Port of Cape Flattery on Cape York Peninsula, and areas impacted by the *Oceanic Grandeur* spill in Torres Strait in the early 1970s.

For further details contact *Norm Duke, telephone +61 77 21 5640; e-mail: nduke@aims.gov.au*

(Steve Raaymakers is currently the Environment Manager with the Queensland Ports Corporation. Opinions expressed through his authorship of 'Slick Talk' are not necessarily those of the Ports Corporation nor the Great Barrier Reef Marine Park Authority.)

New Publications

	Price
Cyclone Sadie Flood Plumes in the Great Barrier Reef Lagoon: Composition and Consequences. A. Steven (ed.), GBRMPA, Townsville, 1997. Workshop Series No. 22. 88 pp. ISBN 0 642 23014 5	$21.40
Trace Metals in Sediments, Indicator Organisms and Traditional Seafoods of the Torres Strait. W. Gladstone, GBRMPA, Townsville, 1996. Commonwealth Coastal Action Program Report Series 5a. 184 pp. ISBN 0 642 25478 8	Postage only
Heavy Metals in Commercial Prawn and Crayfish Species in the Torres Strait. E. Evans-Illidge, GBRMPA, Townsville, 1997. Commonwealth Coastal Action Program Report Series 5b. 111 pp. ISBN 0 642 26442 2	Postage only