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Report on a workshop to review water quality monitoring and its impacts in the nearshore

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Monitoring is integral to scientific research and natural resource management to ensure sustainable use and conservation of coral reef ecosystems. CRC Reef Research Centre began a review of monitoring in the Great Barrier Reef World Heritage Area in December 2001. The objectives of the review were to:

- Collate information about current biophysical and social monitoring in coastal and reef ecosystems within the Great Barrier Reef World Heritage Area.
- Present the information spatially using a Geographic Information System (GIS)
- Critically analyse existing monitoring programs to improve efficiency by identifying gaps, overlaps and potential for increased efficiencies in the way limited resources are used
- Develop an integrated monitoring system in collaboration with CRC Reef partners and other organisations with an interest in monitoring.

The review began by collecting information about monitoring programs that were long-term (more than three years) or represented a significant baseline study. Short-term studies, and those outside the World Heritage Area boundary, were excluded.

For each monitoring program, a short summary; objectives; start and completion dates; keywords; monitoring targets; monitoring methods; data format and accessibility; funding organisations; and details for contact person, were recorded. Location information was also requested. These details were recorded in an Access database with spatial information linked in a GIS layer. By July 2002, about 60 monitoring programs were identified with a further 30 monitoring programs being captured in the database by November 2002. It is intended that the database and spatial information will be available on the CRC Reef website by November 2003.

In July 2002, interested parties were invited to review monitoring programs captured in the database. At that meeting, it was decided to hold “cluster” meetings to enable organisations with complementary interests to participate. The first “cluster” meeting of organisations involved in monitoring water quality and its impacts in the nearshore was held in Townsville on 21 November 2002.

The workshop was organised by CRC Reef Research Centre and attended by 37 people from Commonwealth (CSIRO Land and Water, Australian Institute of Marine Science, Great Barrier Reef Marine Park Authority) and State (Department of Primary industries, Environmental Protection Agency, Department of Natural Resources and Mines) agencies and community organisations (Woongarra Marine Park). A list of participants is attached.

Monitoring database

The workshop began with discussions about the CRC Reef database of programs that monitor water quality or nearshore communities. There are about 40 water quality monitoring programs listed in the database, however, the participants noted that:

- the programs were set up with different objectives – most were not designed to monitor water quality into the Great Barrier Reef.
- few have secure funding for the long term.
- the results from some projects are not scientifically robust.
- many programs produce results which are not applicable to potential users.
- the results from some projects may not be widely accessible.
- the programs are not integrated.

The large number of programs give a false impression of the amount of work that is being done to establish the impacts of water quality in the nearshore. It was suggested that an additional field is added to the database to incorporate likelihood of future funding (and continuation). Some additional information should also be supplied with the database to indicate which programs provide results that can be used to assess impacts on the Great Barrier Reef World Heritage Area (GBRWHA).

The following programs are not included in the CRC Reef database and need to be captured.

RIVERS	• Flow discharge (DNRM) • Herbert River (CSIRO) • Nutrient/sediment Burdekin • Johnston River (DNRM) • Fitzroy River • regional WaterWatch • CRC Coastal information
COASTAL	• Port Curtis integrated coastal study • All ports along Queensland coast have monitoring programs
GBR LAGOON	• Flood plume monitoring (GBRMPA)
ESTUARIES	• Long-term monitoring (DPI) • Trinity Inlet acid sulphate (DNRM)
SEAGRASSES	• Green Island seagrasses (Len Mackenzie, DPI) • Townsville /Port Hinchinbrook port programs
NEARSHORE CORAL REEFS	• Coral cores • Princess Charlotte Bay/ Wet tropics study (Fabricius, AIMS) • Sediment monitoring (JCU) • Turbidity (Wolanski, AIMS)

There is a lack of monitoring of subtidal seagrasses.

Presentations were made by Ms Sheriden Morris (GBRMPA) about policy framework for water quality and the GBRWHA and by Mr Jon Brodie (JCU) about his recent review of water quality monitoring in the Great Barrier Reef World Heritage Area (GBRWHA) and proposal for an integrated monitoring program.

Sheriden Morris
Director
Water Quality and Coastal Development Group, GBRMPA

Sheriden gave a strategic overview of the background of the policy framework for water quality.

In 2001, the **Great Barrier Reef Ministerial Council** requested information about the impact on World Heritage values of declining quality of water entering the Great Barrier Reef lagoon, and actions needed to eliminate the threat.

In response to the request, the **Great Barrier Reef Marine Park Authority** (GBRMPA) prepared a **Great Barrier Reef Catchment Water Quality Action Plan** that recommended end-of-river targets for the year 2011 for discharges of sediment, nitrogen and phosphorus for 26 Queensland rivers. The Plan does not specify how to meet the targets, or how to monitor or enforce them. For more information see: www.gbrmpa.gov.au/corp_site/key_issues/water_quality/action_plan/index.html.

The GBRMPA manages water quality issues occurring within and directly adjacent to the Marine Park. This includes point source discharges such as sewage treatment outfalls that discharge directly into the Marine Park. Outside the Marine Park, the GBRMPA only oversees point source discharges from aquaculture facilities. For more information see: www.gbrmpa.gov.au

In August 2002, the Commonwealth and Queensland Governments announced a **Memorandum of Understanding** (MOU) to protect the Great Barrier Reef from land-sourced pollutants. The two governments committed to develop a **Reef Water Quality Protection Plan**. The Plan will focus on diffuse sources of catchment pollution because point sources such as mines and sewage and aquaculture are already regulated. For more information: www.ea.gov.au/coasts/pollution/reef/

Both Governments will work with regional natural resource management (NRM) bodies (established under the National Action Plan for Salinity and Water Quality, and the Natural Heritage Trust – see below) to set water quality targets and develop catchment specific actions. Both Governments will also both pursue their own initiatives to protect the GBR from land-sourced pollutants.

As part of these initiatives, the Queensland Government established a **Scientific Review Panel** to: summarise evidence on water quality impacts; advise on methods for setting end-of-river targets; and identify the most practical options to reduce water quality impacts on the GBR. The report is not yet available. (The Scientific Review Panel was appointed by the Reef Protection Taskforce which is a Queensland Government initiative).

The Commonwealth Government asked the **Productivity Commission** to determine the importance of industries in the GBR catchment. The Commission is an independent Commonwealth agency that reviews and advises the Government on microeconomic policy and regulation. The Commission was also asked to report on the costs and benefits of on-ground actions to address declining water quality. The interim report from the Productivity Commission was released on 20 November 2002, with a final report due to be released in February 2003. The draft report of the Productivity Commission entitled, Industries in the Great Barrier Reef Catchment

and Measures to Address Declining Water Quality is available at http://www.pc.gov.au/study/gbr/draftreport/index.html

Funding for this initiative is from the **National Action Plan for Salinity and Water Quality** (NAP) and the Natural Heritage Trust (NHT). The NAP is a joint initiative of the Commonwealth, State and Territory Governments. There is funding of $700 million over seven years (2000-01 to 2006-07) from the Commonwealth matched by State and Territories. In March 2002, the Queensland and Commonwealth Governments signed a bilateral agreement for implementation of the NAP with each to invest up to $81 million. The NAP has identified priority regions in several catchments adjacent to the Marine Park including the Burdekin, Burnett, Boyne, Fitzroy and Mary catchments. The funds will be delivered to these areas through natural resource management (NRM) bodies which need to develop NAP accredited NRM plans. The NRM bodies must have a majority of community members and include local government and Indigenous interests. NAP funds will not be available for catchments in the Wet Trropics.

The Australian Commonwealth Government established the **Natural Heritage Trust** in 1997 to "help restore and conserve Australia's environment and natural resources" (www.nht.gov.au). By 2002, Aus $1.4 billion had been invested in more than 11,900 projects involving 400,000 people across Australia. In 2001, the Commonwealth Government committed a further $350 million to the NHT (often referred to as NHT2). These funds will be delivered through Coastcare, Landcare, Bushcare and Rivercare programs through accredited integrated NRM plans.

In July 2000, the **Environment Protection and Biodiversity Conservation Act 1999** came into force. It prohibits actions that have, will or are likely to have a significant impact on the environmental values associated with Commonwealth land, including World Heritage Areas.

Jon Brodie
Senior Research Fellow
Australian Centre for Tropical and Freshwater Research (ACTFR)
James Cook University (JCU)

Jon Brodie distributed a draft report reviewing all water quality monitoring in the GBRWHA and proposal for an integrated monitoring plan. The report was commissioned by the GBRMPA and is due to be released by Jan 2003. The report will be accessible from GBRMPA's website (www.gbrmpa.gov.au) and ACTFR website at JCU (www.actfr.jcu.edu.au). It is planned that the information from this report is fed into the Reef Water Quality Protection Plan

The **Executive summary** of his report is reprinted below.

Water quality management initiatives for the Great Barrier Reef World Heritage Area (GBRWHA) include setting targets (performance objectives) for Great Barrier Reef (GBR) Catchment discharge of suspended sediment, nitrogen and phosphorus; chlorophyll concentrations in the GBR Lagoon; and toxic chemical concentrations in GBR sediments (Great Barrier Reef Catchment Water Quality Action Plan). To successfully assess management performance against the targets an integrated GBRWHA water quality monitoring program is essential.

The principal tool to audit the reduction of land-sourced loads of pollution to the GBRWHA and performance against targets is an end-of-catchment plus in-catchment source monitoring program. Monitoring inside the GBRWHA (eg reef benthos, seagrass and phytoplankton/chlorophyll monitoring) also has a role in auditing performance but the signal detection time is very long (normally > 10 years). River discharge load monitoring has the advantage of detecting changes in load due to catchment management works in a more usable timeframe (4 – 10 years).

A number of components of a GBR water quality monitoring program were started in the late 1980s and early 1990s. These included a river load discharge program focussed on seven of the major rivers of the GBR Catchment; a chlorophyll monitoring program in the GBR Lagoon; a Long-Term Monitoring Program (LTMP) for coral reef benthos and fish in the GBR; and surveys of pesticide, organochlorine and trace metal concentrations in intertidal and subtidal GBR sediments. While some of these components were directly targeted at water quality issues (e.g. the river discharge and chlorophyll programs), others treated water quality only as a peripheral issue (e.g. the LTMP). Many of these programs are now coming to a conclusion either through completion of the program aims or cessation of funding support. It is essential to build on the results of these programs as a baseline for auditing catchment management initiatives for the GBR Catchment.

The general objectives of the monitoring program are to:

- Identify and quantify sources of pollutants to the GBRWHA
- Assess trends in delivery of pollutants (loads) to the GBRWHA
- Measure progress of implementation of pollutant-reducing initiatives on the GBR Catchment
- Identify the 'sink' areas of land-sourced pollutants in the GBRWHA
- Measureme trends (spatial and temporal) in the concentrations of pollutants in compartments of the GBRWHA – water column, sediments, biota
- Assess the effects of pollutants on GBRWHA ecosystems and trends in the status of GBRWHA ecosystems related to terrestrial runoff
- Assess the effects of terrestrial runoff on the GBRWHA in relation to other stresses and impacts

An integrated water quality monitoring program for the GBRWHA requires the following components:

1. **River monitoring network**. This component is designed to determine pollutant loads at the mouths of the major rivers of the GBR catchment and estimates of pollutant source in each catchment. A catchment model will be an essential interpretive component of the network.

2. **Chlorophyll monitoring program** with a station design able to follow both spatial and temporal patterns in chlorophyll in the GBRWHA.

3. **Water temperature monitoring program**. This program should utilize both fixed loggers, oceanographic cruise data and satellite data to cover the required scales of the GBR. Such a program is essential for information about global climate change and mass coral bleaching as well as forming part of the water quality program.

4. **Toxic chemical residue monitoring**. This program will continue and extend the intertidal and sub-tidal sampling surveys already begun so that temporal change in toxicant levels can be assessed.

5. **Seagrass monitoring**. For conclusions to be drawn about changes in seagrass area, biomass or health, and how these changes may effect seagrass dependent animals such as dugongs, turtles, prawns and fish, a program to detect long-term changes in seagrass habitat is required.

6. **Inner-shelf coral reef monitoring**. The current benthic coral reef monitoring in the GBR (the LTMP) is not designed to detect water quality driven degradation of inner-shelf reefs. An inner-shelf reef monitoring program designed to specifically measure water quality impacts is essential.

7. **A modelling program to integrate results from the above components**. The science of water quality impacts, originating from catchment pollution, on GBR ecosystems is a complex story. To interpret data from the different components of the monitoring program set up to assess management performance strong modelling capabilities are required.

The river monitoring network is essential for the assessment of catchment management initiatives to measure the loads of suspended sediments, nitrogen, phosphorus and pesticide residues at a whole-of-catchment scale i.e. at the river mouth. This measure is also essential for auditing progress towards targets for reduction of pollutant loads to the GBRWHA. In addition to total catchment loads measures of sources of loads at a landuse or sub-catchment scale are also essential. For this purpose sampling at a sub-catchment scale is also required on some catchments. Desirable catchments to include in the river network are the Jardine, Normanby, Endeavour, Daintree, Mossman, Barron, Russell-Mulgrave, Johnstone, Tully, Murray, Herbert, Black, Ross, Haughton, Burdekin, Proserpine, O'Connell, Pioneer, Plane, Fitzroy, Calliope, Boyne, Baffle, Kolan and Burnett. Priority catchments which must be included in the monitoring program are Normanby, Daintree, Barron, Russell-Mulgrave, Johnstone, Tully, Herbert, Burdekin, Proserpine, Pioneer, Fitzroy and Burnett.

Many GBR catchments are readily divided into an upper catchment dominated by a mix of land-uses such as natural (forest), small scale mixed cropping, dairy farming and rangeland beef grazing and a lower catchment dominated by cropping (sugarcane and horticulture) and urban development. This pattern occurs on the Mossman, Barron, Russell-Mulgrave, Johnstone, Tully, Herbert, Haughton, Burdekin, Proserpine, O'Connell, Pioneer and Burnett Rivers. For these rivers a sampling station representative of the upper catchment plus one or more stations near the river mouth will separate loads from the upper and lower catchments and their contrasting land-uses. For rivers such as the Fitzroy where major cropping areas occur on the upper catchment a different sampling strategy is required.

In general for the purpose of determining total loads and major sources of loads to the GBRWHA, 1 - 6 sampling stations per catchment will be required. For more intensive examination of catchment dynamics, as may be required under the Nation Action Plan for Salinity and Water Quality (NAP), a larger network of stations will be necessary. All sampling stations need to be associated with gauging points so loads can be measured. Integration of sampling with sampling already conducted by Queensland Department of Natural Resources and Mines (DNRM) is desirable.

An interpretation/modelling facility is essential for the detailed design of the monitoring network and interpretation of monitoring data. This facility should be regionally based in the GBR Catchment and draw on the expertise of James Cook University (ACTFR) and CRC Reef, CSIRO, GBRMPA, DNRM, QEPA, Central Queensland University and the Coastal CRC. The initial task of the facility will be catchment target refinement using data-based modelling and the detailed design of the monitoring network. In the longer term the primary task will be interpretation of monitoring data (including modelling) and reporting.

Discussions began with an outline of State and Commonwealth initiatives on water quality by Mr Andrew Moss (Environmental Protection Agency), Mr George Rayment (Department of Natural Resources and Mines) and Dr Christian Roth (CSIRO Land and Water).

Andrew Moss, EPA
EPA focuses on monitoring ambient water quality in rivers and some estuaries and no programs in the oceans. Dissolved oxygen is monitored in several estuaries which is an important indicator for the survival of some coral reef fishes that have larval phases in estuaries. Targets could be developed using ambient levels via the Environmental Protection Policy which provides statutory regulation. EPA is working with DNRM to develop some Strategic Investment Proposals (SIPs).

George Rayment, DNRM
NAP and NHT2 are major players in SIP projects. NHT2 will have up to $890,000 per annum for projects across 14 NHT regions. “State programs” need to be relevant across all programs.

A Queensland Science Advisory Group is being developed which will be linked to regional bodies and will have technical groups below them.

The Department of State Development has a $30 million sugar development package with $10 million of that package possibly directed toward monitoring of proxy indicators, such as nutrients in surface soils near sugar and banana farms. DNRM also takes annual water statistics which could be a useful proxy indicator for runoff.

Christian Roth, CSIRO Land and Water
Christian is a member of the Dry Tropics NRM Board and can link NRM needs and research required.

Farmers need information about how their practices affect the Reef. Proxy indicators will be critical.

Ian Prosser, CSIRO
Modelling can value-add to monitoring. Models can be used to speculate about other catchments and look into the future given different land-use practices. Models require data from monitoring programs to check their accuracy.

General discussion
Some major gaps in monitoring and/or in understanding of water quality issues are: flow of groundwater; deep-water seagrasses; and changes to fish habitat in coastal areas. There is a need for better information about socio-economic changes.

It is essential to establish indicators of reef health to decide which programs are providing results that will help to assess impact on the GBR. Proxy indicators, such as land cover, stocking numbers, riparian vegetation, grass cover of biomass and pasture condition in catchments, or sewage effluent discharge may be useful indicators.

It was noted that a better signal of change may be detected earlier and more efficiently in the upper catchment rather than in nearshore communities. However, capturing all monitoring programs that are ongoing in the GBR catchments as well as within the GBRWHA would be an enormous job and it is unlikely this could be done in the CRC Reef database.

To ensure that the limited funding available for monitoring is used most efficiently, it was suggested that areas at high-risk from impacts of water quality are identified and that monitoring is concentrated in these areas. Areas at high risk from impacts of water quality are from Port Douglas to Hinchinbrook and from the Whitsundays to Mackay which includes about 209 reefs, or 28% of the inshore reefs in the Great Barrier Reef World Heritage Area. It was pointed out that monitoring will also be needed in other areas because our predictions of high-risk areas may not be accurate.

In the future, there may be other threats to the Reef, such as increasing population pressure along the coast, and inflow of genetically modified organisms. Proposed monitoring should capture any changes that are likely to occur due to these pressures. A link to climate change and global warming also needs to be made.

Proposed monitoring should be linked to management. For example, monitoring the distribution of some organochloride residues at sea may not be useful because they are no longer used, and no management regimes can be established to alter the distribution. We need to monitor for future risks, such as nitrogen/phosphorus and impacts of changes in water usage.

Community groups are keen to adapt their monitoring to ensure that it can be useful in an integrated program.

Traditional monitoring is very labour intensive and therefore expensive. Alternative methods to traditional monitoring need to be found. For example, AIMS are establishing biomarkers for coral stress and using satellite imaging of sea surface temperature to predict coral bleaching.

Modelling can value-add to monitoring by integrating information and making predictions over wide areas without the need for widespread monitoring. It can also make predictions over areas where monitoring cannot be undertaken. However, models will always need data to ground-truth predictions.

It is important to ensure that results of monitoring are reported to increase knowledge and change behaviour. Feedback to landholders about changed water quality as a result of changed practices at the farm level would be an effective way to improve land-use practices.

Fundamental marine data sets need to be identified, such as held at the National Oceans Office. There is an obligation to maintain these data sets. Data sets of water quality monitoring should also be identified to ensure they are maintained and remain accessible.

Actions

Actions arising from the meeting:

- Jon Brodie to establish a committee to create better models of risk. (The first meeting was held at AIMS on December 10).
- Jon Brodie's proposal for an integrated water quality monitoring program needs to be fed into the Reef Water Quality Protection Plan. This will take place via GBRMPA to assist co-ordination of data collection and integration of programs.
- EPA and DNRM are working on Strategic Investment Proposals (SIPs) on water quality for Fitzroy and Burdekin catchments.
- CRC Reef will work with stakeholders to design an integrated monitoring scheme for the nearshore.

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