# CATCHMENT TO REEF

## New tools for mitigation and monitoring of water quality and ecosystem health

Richard Pearson and
Garry Werren

Rainforest CRC

CRC Reef Research Centre

# CATCHMENT TO REEF: NEW TOOLS FOR MITIGATION AND MONITORING OF WATER QUALITY AND ECOSYSTEM HEALTH

Report on Workshop on
Aims, Links, Liaisons, and Outcomes
April 10, 2003

Convenor – Richard Pearson
Report notes – Garry Werren

Rainforest CRC and Reef CRC Joint Program

Established and supported under the
Australian Cooperative Research Centres Program

ISBN 0 86443 704 8



Published by the Cooperative Research Centre for Tropical Rainforest Ecology and Management. Further copies may be requested from the Cooperative Research Centre for Tropical Rainforest Ecology and Management, James Cook University, PO Box 6811 Cairns, QLD, Australia 4870.

This publication should be cited as: Pearson, R. and Werren, G. (2003) *Catchment to Reef: New tools for mitigation and monitoring of water quality and ecosystem health.* Cooperative Research Centre for Tropical Rainforest Ecology and Management. Rainforest CRC, Cairns. ( 32 pp)

September 2003

# CONTENTS



**Contact details:**

CATCHMENT TO REEF JOINT PROGRAM

Prof. Richard Pearson,
School of Tropical Biology
James Cook University
Townsville QLD 4810
Phone: 07 4781 5466
Fax: 07 4781 5511
E-mail richard.pearson@jcu.edu.au

# BACKGROUND

The joint program will develop cost-effective tools necessary to assess impacts of catchment activities on the health of waterways and coastal environments, and especially to measure performance of improved land management. This preliminary workshop, chaired by Sir Sidney Schubert, Chair of the Rainforest and Reef CRCs, aimed to:

- inform organisations concerned with land and water management of the aims and approach of the research program;
- seek feedback on the proposed research;
- seek feedback on preferred outputs and likely outcomes of the program;
- seek appropriate connections with relevant organisations and their past, current or planned monitoring programs; and
- explore opportunities for collaborative extension of the program.

A large number of organisations were able to send representatives (Appendix 1); apologies were received from a number of invitees, most of whom were represented. The workshop program (Appendix 2) commenced with an outline of the research plan from CRC CEOs and research leaders, then provided each representative the opportunity to speak briefly on:

- their interests in land management and/or water quality issues;
- their water-quality-related activities: past, current and planned;
- possible links between their organisation and the joint CRC program;
- possibilities for future joint initiatives; and
- feedback on the proposed research program (Appendix 3).

Breakout sessions allowed small groups to discuss a number of issues, ranging from micro to macro-scale (Appendix 4). Each group judged what was most important to address and balance the available time among the themes. Not all themes could be addressed adequately in the time available.

This report summarises the content of each presentation and of the results of group discussions, and provides a framework for future consultation and collaboration between the research team, partners, and other interested parties.

# PRESENTATION SUMMARIES

## 1. Introduction – Sir Sydney Schubert

Sir Sydney welcomed all participants. Advised that CRCs normally attained 2 terms – third terms possible but also Supplementary Grants – in this case a bid to mount a project aimed at ICK for the Reef was successful. $$ will flow from July 1, 2003 for 3 years – meanwhile both Boards of Rainforest and Reef CRCs will meet to bid for a 3rd term (5th Yr Review). This initial workshop is for information, to seek feedback on proposed research and outcomes, for networking, and to explore extension opportunities.

## 2. Prof. Nigel Stork, CEO, Rainforest CRC

Welcomed delegates and provided a background: the original Rainforest CRC was very biologically focussed but through its first term the focus changed to regional resource management. It now plays an important role in supporting the Regional NRM body, including projects on road design, climate change, water quality, indigenous rainforest management and involvement, etc. Two years ago Sir Sydney Schubert took over the Chair of the Rainforest CRC, promoting more collaboration with the Reef CRC, resulting in the bid for this project. The collaboration is expected to be funded at $1.2M p.a. for 3 years. Partners are JCU, AIMS, GU, CSIRO, NR&M, EA, UQ. We aim to have initial draft products in approximately 12 months.

## 3. Prof. Russell Reichelt, CEO, Reef CRC

There is a strong sense of obligation to deliver something. Three messages from CRC Reef are:

1. solve problems – the big picture problem is clear water quality decline;
2. seek partnerships for best synergistic outcomes; and
3. focus on users of Reef.

Science must work on the problems so as to effect outcomes – scientists should be “on top” not just “on tap”. Beware of complacency – cannot relax; need to form new partnerships to deliver outcomes.

## 4. Mr. Brad Dorrington, Wet Tropics NRM Board

The NRM Board represents the structure through which regional outcome delivery will be effected. The “Region” includes catchments from Crystal Creek north to Daintree River (including the upper Herbert, which is not in Wet Tropics bioregion). The Wet Tropics NRM Board is a company limited by guarantee, with sector representatives, and must communicate with the community and meet annually. A community survey identified some deficiencies, especially with regard to ensuring equitable geographic organisation and representation.

Current partnerships with the Rainforest CRC include services provided by the CRC towards developing the WT NRM Plan, the WT Bama Plan and the WT Regional Director. Current work on WQ Access for Sustainable Agriculture is NHT funded, has engaged landholders, focuses on the Tully and Upper Barron Rivers, and in its second phase will turn attention to the Russell-Mulgrave Rivers.

The good planning of the Board needs to be mirrored by effective outcomes, which are urgently needed.

## 5. Ms. Sheriden Morris, GBRMPA

Main points raised were:

- It is good to see strong representation for this key Wet Tropics region. Recent Marine Park restructuring includes a focus on the Action Plan on Water Quality inflow to the Great Barrier Reef, and there is now joint Commonwealth/State assurance of action to address water quality decline.
- There is in place a "no regrets package", the Action Plan for Reef Protection or Reef Protection Plan. The Plan looks at Local Government responsibilities and industry groups – it is clear that realistically there are broad responsibilities. Technical assistance is provided to regional NRM bodies.
- It is very important that any gaps are identified early as this is a political process.
- This project should lead to implementation of scientifically informed actions.
- NRM – "Not Really Marine" – how will this deficiency be addressed in the emplacement of regional bodies?

*Discussion:*

*BD*: there will be marine user representation.

*SM*: there will be an accreditation process and scrutiny of the regional Board.

*NS*: need outcomes not just outputs – these often done by other people – who will use the tool kits? How will this implementation be achieved?

*DB*: Commonwealth interest in involving marine and coastal users; informs that Lex Cogle's group (NR&M) also takes the marine/coastal stakeholders into account.

## 6. Prof. Richard Pearson, JCU – Background to Project Tasks

The background to the program includes the knowledge that the tropics is very different climatically, hydrologically and biologically from other regions so that the science of assessing and monitoring water quality and ecosystem health needs to be derived locally. Models used elsewhere will be tested and calibrated for the tropics, leading to a suite of locally relevant tools to be adopted by relevant agencies. These tools will define the what, where, when, how and who of monitoring, with protocols appropriate for different skill levels and for different purposes. The focus will be on improvements in land and water management, particularly with regard to riparian and farm management, river health, water quality, restoration activities and marine impacts (reefs, sea grass beds, etc.). The context will include a framework of linkages, from catchment to reef via water and organisms. Paralleling tool development will be training workshops for practitioners, and training of postgraduate students.

## 7. Dr. Miles Furnas – Reef CRC tasks

Reef CRC has had a long-term interest in what is coming out of wet tropic catchments. This new partnership will explore and clarify these processes. Reef health assessment has been historically census-based, which is not always sensitive, often backward-looking, very resource-hungry and time consuming. It is necessary to get smarter, using more rapid assessment techniques. Needs include:

- better techniques to determine "dosages" of runoff in marine environments;
- better measures of contaminants, and of capacity for reef recovery;
- development of passive sampling technologies to improve auditing/monitoring activities; and
- reliable indices to paint a broader picture of reef health and sensitivities/resilience.

The tasks will include (i) physical measures in sea grass and coral habitats, (ii) passive sampling technologies and (iii) remote sensing validation, involving technique development

(year 1), complete laboratory experiments and field testing (year 2) and verification of performance and development of operating procedures for agency use (year 3).

## 8. Dr. Roger Shaw, CEO, Coastal CRC

Some of Coastal CRC's projects are highly complementary to this adaptive management, with related activities in estuaries and wetlands. Projects have a place-based approach, with several elements relevant to this project, such as contaminant pathways in Port Curtis, and floodplain wetlands in the Fitzroy. Similarly, Coastal projects aim for end-of-catchment targets, indicators and performance. Remote sensing (Seabat) technology improvements will facilitate rapid near-shore mapping and high resolution. Partners include academic institutions (Curtin, JCU, etc) plus small-medium enterprises. An Adaptive Management Framework ensures that all projects must line up with each other, with the underpinning guideline "unified learning universally shared makes wise choice possible".

## 9. Mr. Mike Berwick – Mayor, Douglas Shire Council (DSC)

DSC recently firmed up its Water Quality Strategy, with the support of Commonwealth funds. Landowners support adopting Best Management Practice within this low risk catchment (it does have fringing reefs). Partnerships between farmers and DSC, CSIRO, Mossman Mill & Canegrowers aim to implement Best Management Practice over entire diffuse sources and point sources. Brian Roberts runs the Joint Venture Program for DSC. Currently, the project is defining catchments and will examine contaminant sources, set targets, consider time lines, costs, actions, monitoring and reporting protocols. There are five projects involving:

- implementation of Best Management Practice (moving to zero tillage, minimising nutrient loss, riparian management and reducing/replacing pesticide use);
- whole catchment focus (Saltwater Creek; Paul Reddell – CSIRO leads), dealing with both point and diffuse sources;
- restoration of riparian/riverine/wetlands – audit, restoration and recovery – will look at restoring many cane drains into floodplain PFPs and wetlands;
- water quality monitoring (CSIRO-led) – purchasing and trialling data loggers etc; high degree of complementarity with present project, although perhaps insufficient consideration of marine issues.

*Discussion:*

*AA*: deficiencies identified regarding assessment of instream health
*MB*: agrees but project was agriculturally driven and needed to be rapidly put in place due to Commonwealth funding opportunity – happy to shore up any integration/interaction/ collaboration with Catchment to Reef project.

## 10. Dr. Chris Margules – CSIRO (Flagship Project)

Main points raised were:

- Healthy Country projects – funded by 10% taken from allocations to all divisions;
- Big increase in benefits from water use working in lower Burdekin: irrigation, future water use, waste from waste, dryland systems, designed ecosystems outputs;
- Dryland system theme relevant;
- Wet Tropics project still developing:
  - CSIRO cash/inkind to Douglas Shire water quality program – CSIRO involved in 4 projects;
  - Longer term view of major impacts;
  - Broadening of wet tropics partnerships;
- Big investment in monitoring infrastructure;
- Aiming at agricultural best practice;
- Real time data delivery to managers;

- Collaboration – exploratory – predictive understanding of impacts: population increase (3 x National average), climate change, structural adjustment;
- Thresholds of concern.

## 11. Mr. Steve Goosem – WTMA

Main points raised were:

- WTMA's management roles (fixed in legislation);
- charter for maintenance of integrity of WHA;
- WT is an island surrounded by matrix of very altered landcover;
- many problems for WHA arise from outside and or flow through – many are inherently hydrological;
- challenge to identify chronic stress *vs*. acute pulse;
- interested in those tools to implement Integrated Ecosystem Management (IEM) – need to understand multiple human impacts and biological responses both spatially and temporally (also interactions, synergies, compounding/amplifying effects, etc);
- interested in outcomes with regard to rehabilitation efforts;
- also interested in a broader conceptualisation of forest health that includes river health;
- previously WTMA largely ignored river health;
- very interested in key regional waterways with regard to ecosystem service/function delivery;
- concerned with a regional drainage system classification – this would:
    - (i) provide a context for stream research results
    - (ii) assist in extrapolation
    - (iii) provide a framework for effects of assessment – helpful for periodic reporting.

## 12. Ms. Dominique Benzaken – Environment Australia

Commonwealth has interests in:

- protection of GBR World Heritage Values;
- responsibilities under the National Action Plan on Salinity and Water Quality with regard to NRM priorities – $350M (NHT) investment in water quality in Qld priority regions (NAP);
- Sugar industry restructure.

Current Commonwealth initiatives:

- RWQPP – overarching to guide regional investment (contact Tony Bigwood);
- Coastal Catchments Initiative – Douglas Shire (contact Vaughan Cox);
- NRM Regional Planning Projects (contact Catherine Masters);
- Wetlands Protection Program (Sugar Package) – $16M (contact Dominique Benzaken);
- Wetlands Protection (NHT Regional & National) – $15M (contacts Catherine Masters/Dominique Benzaken).

Developing a national approach to coastal issues. Issue of integration of management framework plus consideration of impacts of climate change:

- Regional Capacity-Building a key element
- Monitoring/Evaluating RWQPP
- Synergies/linkages
    - NRM Regional Delivery (DS-CCI/Reef Catchments)
    - Consistent reporting framework/National WQMS consistent
        (Contact Kerry Rose) (Contact Charles Lewis)

Good science for good investment – i.e. obtain tangible outcomes that are value for money.

## 13. Mr. John Bennett – EPA

Discussed processes within EPA relevant to water quality:

- Environemntal Protection (Water) Policy (1997);
- guidelines – EPA products and services directory; Qld WQ guidelines (draft);
- WQ environmental values and WQ objectives – Trinity Inlet, SE Qld, Mary River, Douglas Shire, etc.;
- strategies/plans – integrated natural resource management plans, etc; set EVs and WQOs, eveauate management options, define implementation actions;
- implementation – licensing of Environmentally Relevant Activities; monitoring and evaluating water quality; etc.;
- adaptive management framework;
- research tasks of present program: what about estuaries and freshwater wetlands?
- target-setting process – preferably using state, regional and local values, goals and targets, and involving defined action plans.

## 14. Mr. Andrew Solomon (NR&M) – Catchment & Regional Issues

Water quality linkages:

- NR&M activities include Water Management, Land, Vegetation, Tropical weed research, Information and Land & Water Science, GIS, Planning, surface/groundwater quality monitoring;
- Water Resource Plans have clear water quality linkages – i.e. a major client for the outcomes of this project *vis à vis* Task 3;
- Possible use of Barron Catchment as a case study, where flows have been documented, hydrology modelled and condition assessment already;
- Some in NR&M involved in coordination of planning input;
- Community-based NRM also an important focus of NR&M, especially support for WT NRM Board;
- N.B. recent audit of Waterwatch (Alan Mitchell has compiled report).

## 15. Mr. Lex Cogle (DNRM Land and Water) Regional Science Coordinator

Priorities of NR&M (North Region):

- water (quantity & quality);
- land (sustainability, off-site impacts, EMS);
- vegetation (Vegetation Management Act compliance);
- pests & weeds (both dryland/aquatic);
- NRM (Board support) at regional level;
- Environmental Management System – Primary Green Projects;
- Vegetation Management – currently a very high priority – Regional Vegetation Management Plan will include experimental areas;
- Regional Water Quality Project – also a variety of WQ related activities – covering all wet tropic rivers plus intensive work on the Johnstone, Barron, Cattle Creek and Tully systems;
- Regional WQ Project has a strong involvement of NR & M – John Armour – also particular interest in Nitrogen flux in catchment related to Catchment land management;
- Nitrogen loss below agricultural systems – sink of $NO_x$?

*Discussion:*

*MB*: Points to lack of coordination among State Government Departments/Agencies.

*AS*: Best Practice Management includes compliance so this should prompt a lot more inter-agency cooperation, coordination and consistency.

*SM*: But how do all of these initiatives feed back into compliance outcomes – needs feedback into legislation and compliance.

*LC*: Landholders don"t want fingers pointed at them.
*SM*: It should be a Government process involving integrated policy, legislation and compliance.
*AS*: Compliance is both voluntary and enforced.
*LR* (Canefarmer): "the rubber is landing on my back, not on the ground" – farmers concerned about enforcement of compliance(?).

## 16. Mr. Don Pollock – Qld Fruit and Vegetable Growers – banana industry

Main points raised were:

- Keen for collaboration – vertical integration with regard to policy as it affects horticultural industry.
- Regional interest in NRM Board and development of Best Management Practice on banana farms.
- Key point to bear in mind – to continue to be viable we must maintain our access to natural resources and manage them accordingly.
- Sustainability viewed broadly (i.e. not just environmental but also economic).
- Last two decades has seen significant increase in banana production in the tropics.
- Approx 10,000 ha of production, in tropics – 500+ enterprises.
- In Wet Tropics region approximately 30 very large producers.
- Horticulture industry has a very cautious approach to regulation – especially if it is poorly thought out, ill-considered and/or misapplied.
- QDPI has produced useful benchmark.
- Strong R&D interests (particularly with regard to production issues – but shifting more to sustainability).
- Very important for industry to play a role in identifying issues and setting priorities in regional NRM context.
- Investigation of accreditation system for environmental management (conducted by David Hind)
- Have had involvement in Tully pilot WQ project – unfortunately dry seasons have limited the interpretability of the data obtained. Banana industry invested in the project in the spirit of self interest to adopt Best Management Practice.
- An industry perspective – certainly interested in project – outputs/outcomes will be considered with a great deal of practical interest.
- Need to stress that we acknowledge that the industry needs improvement.

## 17. Mr. Peter Sheedy – Canegrowers

Main points raised were:

- Sugarcane a weather-driven crop – natural interest in land management and water quality issues.
- Cane occupies about 2% of catchments draining in GBR.
- Producers rely on good service.
- Productivity and efficiency key drivers.
- Industry remains unconvinced by science in GBR health debate.
- Improved on-farm practice – 1980-2002 – 0% to about 62% of total Qld crop green harvested resulting in reduction of sediment, nutrient and pesticide loss – decline of Nitrogen loss per hectare over last 3 years.
- Measured water samples do not support decline in health of GBR lagoon.
- There is a "religion" dimension to this issue.
- COMPASS program is an industry initiative and there has been improved environmental management.

## 18. Mr. John Reghenzani – BSES

Main points raised were:

- Considerable cooperation in industry research.
- Inner reef is deteriorating – agriculture raises nutrient load – nutrients adversely influence coral and the precautionary principle is supported.
- Tully data indicates non-significance increased trend in nitrate.
- Has been a 5.5% increase in phosphorous.
- Nutrient Balance Project – crop uptake is of major importance in the nutrient balance (once in crop, less likely to get into environment).
- Green cane trash blanketing residues greater source of nutrients in canegrowing areas.
- Has been a great achievement with the introduction of green trash blanketing and much of this has been documented in detail by BSES and collaborators.
- Also Codes of Practice, Training of Trainers and Extension personnel by CRC Sugar.
- COMPASS is a very useful extension tool acceptable to landholders – overcomes earlier compliance with Code of Practice.
- New CRC (replacing Sugar CRC) is Biotechnology CRC – looking at genetics of improved Nitrogen uptake.

## 19. Mr. Les Robertson – SRDC

Main points raised were:

- SRDC has annual budget of >$10m – high emphasis on whole of industry sustainability and more accountable environmental practices.
- 4-program structure, includes farming systems (2/3 budget), processing systems and industry capacity.
- Targeted call for preliminary R & D proposals advertised in August for projects commencing in July 2004.
- Project proposals need to take a systems approach to identifying and implementing solutions to problems.
- Water Quality Workshop – tentatively in August at Townsville – main premise is that we can improve our practices, and focussing on pathways through which improvements can be practically achieved.
- Harvesting improvements also an R & D priority – up to 25% sugar let on ground – economic benefits in increased sugar recovery as well as environmental outcomes.

# SUMMARY OF BREAKOUT GROUP DISCUSSIONS

| Task/ Issue | Group comments | Status/action |
|---|---|---|
| **General comments** | Project is about development of methods, not about monitoring /assessment *per se*. | Implicit in program description |
| | Tasks 2 and 3 should be closely integrated – water quality is part of river health | Noted. Close interaction intended, including shared personnel and, where appropriate, shared sites, shared sampling, etc. |
| | Need to tightly specify what the products are – i.e., the meaning of "tools" | Noted. Subject of early discussions, and communication with interested parties |
| | Need to piggy-back on existing projects to maximise output | Intended – e.g. close liaison with monitoring in the Tully and Mulgrave; involvement with Douglas Shire project |
| | Need development of institutional framework for long-term monitoring of water quality and catchment health in GBR catchments and the GBRWHA | Noted. To be pursued through appropriate channels (including Steering Committee) |
| | Need conceptual model of catchment-reef processes on which to base monitoring – justification of monitoring sites, methods, parameters, timing | Implicit in program approach, including detailed catchment studies; testing and refining the model is a major component of the program |
| | Need to develop aquatic health guidelines, in collaboration with he EPA | Output implicit in program, as is collaboration with relevant agencies |
| **Task 1** | Link to audit of vegetation (Rainforest CRC Prog 5 – C. Catterall) | To follow up |
| | Include ecological as well as contaminant stripping roles | To be included in review, guidelines, etc |
| | Compare filtering functions of trees, grasses, etc. | Implicit in approach to task |
| | Address the cause of runoff from catchments – do not rely solely on riparian vegetation as a mop-up mechanism | Implicit in approach to task |
| | Aim to improve the quality of run-off | Monitoring tools aim to identify improvements in land-management performance |
| | Need to emphasise interactions with landowners, and improvement of their practices | Liaison with relevant agencies, farming groups and individuals, on-farm, through workshops and via extension activities of agencies |
| | Must be careful that we don't overlap, "reinvent the wheel" | Noted – liaison/workshops with relevant groups, and testing of models from elsewhere will be part of program |
| | An assessment of what has already been done is needed across the board | Review and appropriate consultation included in the tasks |
| | Require framework of existing outputs/existing gaps in knowledge | Noted – to be included in task reviews |
| **Task 2** | Health-assessment protocol should be applicable to urban streams – restoration of ecological values of urban streams is a worthwhile goal | Noted, and to be addressed in protocol development |

| | | |
|---|---|---|
| Task 2 (cont) | Project is focuses on diffuse sources – could have more focus on some point sources (e.g., aquaculture) | Point sources such as minor tributaries from discrete subcatchments are included; others will be addressed |
| | What are the cumulative impacts? What ceilings are acceptable? Are there critical thresholds of water quality change? | Questions to be workshopped early to seek ways of addressing them |
| | What is the "natural range of water quality values" in systems subject to wide natural flow variations and years of cumulative impacts? | Benchmarks relating to different conditions will be necessary: implicit in approach to tasks 1 and 2 |
| | Douglas will be using existing monitoring tools – it would be good if some "performance-monitoring of tools" is undertaken | Noted – to be addressed in tasks design |
| | Fast track output (i) – guidelines for site selection etc. – particularly with respect to: technology, location, parameters; scoping required before July | Noted, but not feasible before July |
| | There should be a load-based emphasis in the Wet Tropics region (and tropical regions generally) | Comment noted especially with reference to materials delivery to coastal waters; concentrations are more informative with regard to within-river ecology |
| | Program should be linked to existing data, infrastructure and policy directions as set out in the forthcoming Reef Protection Plan | Noted – this will be addressed |
| | Issues that need to be resolved: charging, IP, release of sensitive information | Noted – to be addressed by Steering Committee |
| | Program still low-level – not much about episodic events, interpretation of data – guidance for interpretation also required | Very much intended as part of guidelines |
| **Task 3** | Consider use of proxy indicators – e.g., catchment condition indicators, and remote sensing | Noted. Surrogates or rapid assessment methods implicit in tasks |
| | Should we go broader to include floodplains? | To be discussed |
| | Health needs to be related to monitoring – what is relationship between Tasks 2 & 3? | Noted. Tasks will be closely linked |
| | Out of these two programs, may come up with a single organism that serves as a useful indicator | Tasks will seek suitable indicators |
| | Linkages between tasks are probably lacking. In particular, there should be an explicit link between physio-chemical and biological monitoring and health assessment | Implicit if not explicit in approach to tasks |
| **Task 4** | Need to classify catchments and streams as components of ICM and restoration | Noted |
| | Capture landholder knowledge of condition of riparian/river systems | Will survey and/or workshop in local area |
| | Make test cases win-win situations for land-holders and other stakeholders | Workshop, and style of outputs will address |
| | Possible sites: Junction Ck – Russell-Mulgrave, drains to Russell River National Park; Moresby catchment – high environmental value, land-use pressure from aquaculture, agriculture, bananas – good for cumulative impacts | Site selection early part of all tasks; will include further consultation, and consideration of parallel monitoring programs |

| | | |
|---|---|---|
| Task 4 (cont) | Value of setting thresholds and targets – could be useful in guiding a decision on, e.g., allowing development of another prawn farm; setting thresholds enables advice on "safe levels" | Noted |
| | Management must involve the community, consider socio-economic factors | Noted – aim to consult community and have appropriate representation in workshops |
| | Need to know current condition and be able to determine if there are improvements | Implicit in program objectives |
| | Suggest that this task liaise with Coastal CRC to utilise the same processes and structure; could identify capacity-building needs | Noted, and to be followed up with Coastal CRC |
| | Consider use of proxy indicators – e.g., catchment condition indicators, and remote sensing | Noted. Surrogates or rapid assessment methods implicit in tasks |
| | Need agency/legislative integration, i.e. before integrating catchment management, we need integration of legislative framework from the federal to the property planning level | Noted, but beyond scope of this program *per se*. |
| **Task 5** | Concept good, but problem linking outputs to outcomes | Noted – for discussion |
| | Need guidelines for a suite of aquatic organisms – corals, macroalgae, seagrass | Likely to be addressed within task |
| **Task 7** | Task difficult – one person not enough – need high level of support to communicate and deliver | Noted; communication and delivery will not be the responsibility solely of one person – program and task leaders will participate |
| **Sites** | Need to link land and marine tasks – suggested systems are Johnstone, Russell/Mulgrave; possibly Tully, Herbert; also Douglas Shire – Mossman R.; and pristine areas, e.g., Princess Charlotte Bay | Links are implicit in program; site selection will focus in this general area; sites yet to be determined |
| **Traditional owners** | Involvement and interest of traditional owners highlighted | Noted. Representation to be invited on relevant groups, at workshops and with respect to particular sites |
| **Stakeholder representation** | Stakeholder reference group required to contribute to a good governance structure and to provide for valuable input, ownership and involvement | Reference group to be established. |
| | Task associates/Program support groups needed | To be considered at a task level |
| **Miscellaneous** | Need a socio-economic task | Noted, but not considered feasible in this program, although socio-economic factors will be addressed during workshops etc. |
| | Modelling of N flows – desk-top study | Implicit in NR&M component of Task 1 |
| | Wonky holes – inclusion? | To be considered, along with other issues to do with groundwater influences |
| **Outputs** | Expected outputs need considering as a matrix to guide appropriate process (see below) | Noted for development and adoption |

# CONCLUSION – NEXT STEPS

Next steps in the development of the program were:

- Development of project proposals
- Signing of agreements with partners and CRC secretariat
- Advertisement of post-graduate scholarships
- Workshop of scientists
- Approval of project proposals
- Commencement of tasks

Richard Pearson requested that all parties provide him with names and contact details of organisations and individuals who should be included on the program mailing list and involved in future consultation/workshops.

Sir Sydney Schubert thanked all participants for their attendance and participation.

# APPENDIX 1. WORKSHOP PROGRAM

| | | |
|---|---|---|
| 08.30 | Coffee, tea | |
| 09.00 | Welcome | Sir Sydney Schubert, Chair, Rainforest and Reef CRCs |
| 09.10 | CRCs – research and application | Prof Nigel Stork, CEO, Rainforest CRC |
| 09.20 | | Prof Russell Reichelt, CEO, Reef CRC |
| 09.30 | Wet Tropics NRM Board – current status | Mr Brad Dorrington, CEO, Wet Tropics NRM Board |
| 09.40 | GBRMPA"s role | Ms Sheriden Morris |
| 09.50 | Background to the Research Program; and research tasks – catchment and waterway health | Prof Richard Pearson |
| 10.10 | Research tasks – coastal habitats and reefs | Dr Miles Furnas, Reef CRC |
| 10.25 | Coastal CRC – complementary programs | Dr Roger Shaw, CEO, Coastal CRC |
| 10.35 | Douglas Shire – land management and water quality program | Mr Mike Berwick, Mayor, Douglas Shire |
| 10.45 | Morning tea | |
| 11.10 | CSIRO"s Healthy Country – Wet Tropics | Dr Chris Margules |
| 11.20 | Wet Tropics Management Authority"s role | Mr Max Chappell |
| 11.30 | Reef Protection Plan and EA"s role | Ms Dominique Benzaken, Environment Australia |
| 11.40 | Water quality and the EPA | John Bennett, EPA |
| 11.50 | Natural Resources and Mines overview | Mr Andrew Solomon, DNRM |
| 12.00 | Natural Resources and Mines program links | Mr Lex Cogle, DNRM |
| 12.10 | Horticulture and water quality | Mr Don Pollock, QFVG |
| 12.20 | Sugar industry perspectives (1) | Mr. Peter Sheedy, Canegrowers |
| 12.30 | Sugar industry perspectives (2) | Mr John Reghenzani, BSES |
| 12.40 | Sugar industry perspectives (3) | Mr Les Robertson, SRDC |
| 12.50 | Summary and briefing for p.m. session | |
| 13.00 | Lunch | |
| 14.00 | Group discussions – challenges, links, synergies, expected outcomes | Richard Pearson |
| 15.15 | Afternoon Tea | |
| 15.30 | Group feedback and general discussion | |
| 16.30 | Close | |

# APPENDIX 2. WORKSHOP PARTICIPANTS

| Surname | Given Name | Email | Affiliation |
|---|---|---|---|
| Arthington | Prof Angela | A.Arthington@mailbox.gu.edu.au | Griffith University |
| Bennett | Mr John | john.bennett@epa.qld.gov.au | EPA |
| Benzaken | Ms Dominique | Dominique.Benzaken@ea.gov.au | Environment Australia |
| Berwick | Mr Mike | douglas@dsc.qld.gov.au | Douglas Shire |
| Brighton | Mr Bob | c/- Don Pollock | QFVG grower |
| Brodie | Mr John | jon.brodie@jcu.edu.au | ACTFR, JCU |
| Cavicchiolo | Mr Mark | Mark.Cavicchiolo@epa.qld.gov.au | EPA |
| Chappel | Mr Max | Max.Chappel@epa.qld.gov.au | WTMA |
| Cogle | Dr Lex | lex.cogle@nrm.qld.gov.au | Dept. of NRM |
| Campbell | Dr Stuart | stuart.campbell@dpi.qld.gov.au | DPI-Fisheries |
| Dorrington | Mr Brad | bradd@znet.net.au | NRM Board |
| Furnas | Dr Miles | m.furnas@aims.gov.au | Reef CRC |
| Margules | Dr Chris | Chris.Margules@csiro.au | CSIRO |
| McJannet | Dr David | David.McJannet@csiro.au | CSIRO |
| Morris | Ms Sheriden | s.morris@gbrmpa.gov.au | GBRMPA |
| Moss | Mr Andrew | andrew.moss@epa.qld.gov.au | EPA |
| Neilson | Ms Wendy | WendyN@znet.net.au | NRM Board |
| Pannell | Ms Sandra | Sandra.Pannell@jcu.edu.au | Rainforest CRC |
| Pearson | Prof Richard | richard.pearson@jcu.edu.au | JCU |
| Pollock | Dr Don | dpollock@qfvg.org.au | QFVG, Innisfail |
| Reichelt | Dr Russell | r.reichelt@bigpond.com.au | Reef CRC |
| Reghenzani | Mr John | jreghenzani@bses.org.au | BSES |
| Rist | Mr Phil | Girrin1@znet.net.au | Aboriginal Consultative Committee, Rainforest CRC; Indigenous Working Group, Reef CRC |
| Robertson | Dr Les | lrobertson@srdc.gov.au | SRDC |
| Schubert | Sir Sydney | sydschubert@bigpond.com | Rainforest & Reef CRCs |
| Shaw | Dr Roger | Roger.Shaw@dnr.qld.gov.au | Coastal CRC |

| | | | |
|---|---|---|---|
| Sheedy | Mr Peter | Peter_Sheedy@hbr.canegrowers.com.au | Herbert River District Canegrowers |
| Simpson | Dr Bruce | bruce.simpson@nrm.qld.gov.au | Dept. of NRM |
| Steven | Dr Andy | andy.steven@epa.qld.gov.au | EPA |
| Stork | Prof Nigel | nigel.stork@jcu.edu.au | Rainforest CRC |
| Turton | A/Prof Steve | Steve.Turton@jcu.edu.au | Rainforest CRC |
| Werren | Mr Garry | Garry.Werren@jcu.edu.au | ACTFR, JCU |
| Weston | Mr Nigel | nigel.Weston@jcu.edu.au | Rainforest CRC |
| Williams | Dr David | d.williams@aims.gov.au | Reef CRC |
| **Apologies** | | | |
| Bigwood | Mr Tony | tony.bigwood@ea.gov.au | Environment Australia, Canberra |
| Chadwick | Ms Virginia | v.chadwick@gbrmpa.gov.au | GBRMPA |
| Creighton | Mr Colin | Colin.Creighton@nlwra.gov.au | Land and Water Australia |
| Dawson | Ms Diana | diana_dawson@canegrowers.com.au | Canegrowers, Brisbane |
| Doherty | Dr Peter | p.doherty@aims.gov.au | Reef CRC/AIMS |
| Gilbey | Mr Peter | Peter.Gilbey@nrm.qld.gov.au | Qld Dept of NRM, Townsville |
| Hunter | Ms Heather | heather.hunter@dnr.qld.gov.au | Qld Dept of NRM, Brisbane |
| Hyne | Dr David | dhyne@qfvg.org.au | QFVG, Tully |
| McDonald | Dr Geoff | geoff.mcdonald@csiro.au | CSIRO, Brisbane |
| McPhail | Mr Ian | ian.mcphail@epa.qld.gov.au | Qld Parks and Wildlife |
| Muchow | Dr Russell | rmuchow@srdc.gov.au | SRDC, Brisbane |
| Mullins | Mr John | john.mullins@dnr.qld.gov.au | Qld Dept of NRM, Brisbane |
| Reddell | Dr Paul | paul.reddell@lwe.csiro.au | CSIRO Atherton |
| Ringrose | Ms Helen | helen.ringrose@premiers.qld.gov.au | Reef Protection Plan, Premier's Dept |
| Roberts | Dr Brian | douglas@dsc.qld.gov.au | Douglas Shire, Mossman |
| Roth | Dr Christian | Christian.Roth@csiro.au | CSIRO Townsville |
| Russell | Mr John | john.russell@dpi.qld.gov.au | QDPI-Fisheries |
| Russell-French | Ms Alison | Alison.Russell-french@ea.gov.au | Environment Australia, Canberra |
| Watkinson | Mr Russell | russell.watkinson@epa.qld.gov.au | WTMA, Cairns |

# APPENDIX 3.
# SUMMARY OF DRAFT RESEARCH PROGRAM 2003 – 2006

## GOAL

To develop new cost-effective tools, protocols and expertise to identify, monitor and mitigate riparian and water quality problems and to assess the functional health of aquatic ecosystems in the Wet Tropics and Great Barrier Reef World Heritage Areas as an essential step towards minimising the downstream effects of agriculture and improving the ecosystem health of the Great Barrier Reef Lagoon and its feeder catchments.

## OBJECTIVES

To address current deficiencies in understanding of condition and processes in Wet Tropics catchments and coastal marine systems of the Great Barrier Reef. The project will develop new cost-effective tools, protocols and expertise to:

1. monitor sediment and chemical exports across riparian borders and assess the relative performance of alternative riparian systems as filters of contaminants from land use;
2. monitor water quality at key points of discharge and assess against benchmarks;
3. measure river health and monitor performance of mitigation measures;
4. identify river restoration priorities (mitigation needs, locations and methods) to reduce land-based impacts on water quality and river health, and achieve “best practice” integrated catchment management to enhance biophysical values of catchments and of the quality of water delivered to coastal marine ecosystems;
5. collect baseline information and monitor trends in condition of coastal marine communities;
6. assess and monitor ecological condition and trends of sublethal stress in aquatic organisms; and downstream from feeder catchments;
7. apply the novel techniques within normal management contexts, through targeted training of the current and new generation of practitioners and managers; and
8. communicate assessments and analysis of research findings widely to government agencies, conservation and industry groups, and the broader community.

## RESEARCH PLAN

### Task 1. Riparian zone performance: tools and protocols for assessment and monitoring, and development of guidelines for improvement.

***Rationale***

A major management tool for improving water quality is manipulation of the riparian zone – the river bank and its vegetation – which is vital for bank stabilisation, shade, organic input, habitat for terrestrial and emerging aquatic fauna, and the filtering out of dissolved and suspended contaminants resulting from catchment land use. A pressing research need is to quantify these roles to facilitate riparian management activities aimed at controlling water quality and simultaneously sustaining processes vital for river ecosystem health. The very special nature of GBR and Wet Tropics catchment hydrology, particularly the rainfall quantity and intensity, and stream flow extremes, create an unusual circumstance in Australia that

demands assessment at this bioregional scale. In this task we will develop the tools to quantify the filtering role of the riparian ribbon, providing the capacity to test the influence of major variables (hydrology, landform, soil type, land use, bank form, vegetation structure, floristics and width of the vegetated zone) and to provide guidelines towards enhancing riparian performance.

***Methods***

The experimental design will involve three linked approaches:

- Assessment of drainage patterns in Wet Tropics streams with respect to agricultural drainage, to identify major contaminant inputs; and selection of representative stream geomorphologies for subsequent studies.
- Testing methods to evaluate water quality (nutrients, sediments, organic material, etc) in surface and subsurface drainage across the riparian zone, under different seasonal runoff conditions, land-use activities and riparian characteristics (e.g., different widths; grass vs. woody vegetation).
- Broad-scale assessment of catchment and riparian performance by comparing subcatchments with different levels of riparian integrity (defined by methods developed in Tasks 3 and 4). Contaminant concentrations will be measured at the end of the subcatchment, providing an integrated assessment of the subcatchment. Subcatchments will be selected across a gradient of use/disturbance classes from intact forest to broad-scale cropping; nested within these classes will be a gradient of riparian integrity. Sampling will follow natural events (e.g., lowest flow, dry season base flow, wet season base flow, bankfull flow and flood) and land-use activities (e.g., fertiliser application and harvest). Subcatchment selection will depend on co-occurrence of catchment characteristics, the potential for downstream impacts and the availability of reference sites: the Russell-Mulgrave, Johnstone and Mossman-Daintree catchments are currently under consideration for this proposal. These catchments have been identified as medium-high risk catchments (GBRMPA, 2001).

***Outputs***

The outputs will be a riparian assessment toolbox, which will provide protocols for assessment of the riparian zone and its filtering role, and of water quality emanating from assorted subcatchments, establishing the basis for guidelines to restore this major function of the riparian zone

## Task 2. Monitoring tools for water quality assessment against benchmarks.

***Rationale***

Water quality monitoring has frequently not been done well because:

- variables such as time of day, extent of instream vegetation and antecedent hydrological and other disturbances are of crucial importance but are ignored;
- end-of-river data do not reflect overall condition – for example, drainage from floodplain agriculture may discharge not through the river but via wetland complexes;
- end-of-river monitoring integrates within-river water quality improvements due to natural processes, but misses the crucial roles of contaminant stripping by wetlands;
- flood-based monitoring quantifies material loads leaving the system but misses periods of steady contaminant transport; chronic inputs to the inshore marine system may be just as important as flood pulses as they supply readily accessible nutrients through the year;
- development of water quality benchmarks or targets has of necessity been attempted without adequate reference to the above considerations and without the benefit of extended analysis;
- there have been inadequate water quality reporting frameworks in both scientific and management spheres.

This task will address these problems by developing cost-effective protocols for water quality monitoring, analysis and reporting. It will establish methods for variable selection and sampling, and develop guidelines for effective site selection through the catchment – at the subcatchment scale, at the river mouth, across floodplain distributaries, and potentially incorporating ground water discharges.

***Methods***
The task will initially be a desk-top study using available data, aerial and satellite imagery, GIS analysis and existing guidelines (e.g. ANZECC – part of its protocol requires regional adaptation as proposed in this task) and workshops with other experts (e.g. QNRM and EPA personnel; ANZECC authors; CRC Freshwater Ecology participants). Ground-truthing will involve water quality sampling at key sites, including reference sites, partly in conjunction with Task 1. The problem of appropriate reporting will be addressed by reference to relevant authorities and other interested parties. It is anticipated that novel reporting methods such as dynamic web pages will be developed.

***Outputs***
Outputs will include (i) guidelines for site selection, sampling design, parameter selection and sampling methodology, water analysis, data analysis, and reporting; and (ii) a review of current water quality targets in the light of this research, in the context of "acceptable deviation from reference" in this unique bioregion.

## Task 3. River health assessment tools

***Rationale***
River "health" is a concept that describes the naturalness (and deviation from it) of river/stream ecosystems; it incorporates measures of physical condition and biological well being, including key components of structure and function such as biodiversity, habitat integrity, food webs and community metabolism, water quality and response to natural disturbances (flood, drought, etc). River health is important because (i) it reflects catchment condition, including, especially, condition of the riparian zone; (ii) healthy river systems provide ideal contaminant-stripping mechanisms; and (iii) healthy river systems support rich biodiversity (including important fishery species) and provide for successful multiple use (e.g. water supply).

A number of indices of river health have been developed that compare measures of different components of the system against measures expected from benchmark or reference sites. Different measures (e.g., dissolved nutrients, diversity of fish) quantify different aspects of "health," and the preferred contemporary model (e.g. in SE Queensland) is to combine a suite of important physical, chemical and biological variables. Given that the Wet Tropics bioregion is very different from elsewhere (in terms of hydrology, biodiversity, etc.), measures, protocols and benchmarks need to be developed separately for this region.

***Methods***
Several independent measures have been developed for Wet Tropic streams by the Rainforest CRC, using reference sites across the bioregion. Here we propose to develop extra measures (including aquatic plants, food webs / community metabolism, and biomarkers of physiological stress that are potentially more sensitive to land-use disturbance and contaminant runoff. This task will integrate these measures into a model of Wet Tropics river health and ecological function, and thereby develop a comprehensive protocol for assessment of river and wetland health. New data will be collected to test the protocol at representative sites (low to high anthropogenic disturbance) and under representative conditions (with respect to seasonal stream flows and land-use activity) in combination with Tasks 1 and 2. We will streamline the methodology to ensure a combination of rapid

assessment, sensitivity and accuracy, and we will investigate the performance of the individual health measures compared with the composite to identify simpler surrogates, should they exist.

***Outputs***
Outputs will include (i) a manual detailing protocols and techniques for river health assessment in Wet Tropics streams; we expect that the manual will be readily adaptable to other tropical bioregions; and (ii) results of the assessment of ecological health for selected tropical streams providing a baseline for future assessment of land-use and riparian management outcomes.

## Task 4. Frameworks for integrated catchment management

***Rationale***
Integrated catchment management is a major goal of natural resources management in the Wet Tropics bioregion, where many forms of land and water use co-occur. Within sub-catchments there are usually several disparate forms of land use, tenure, protection, and disturbance. Managing the quantity and quality of riparian and catchment forest cover within such landscapes has been linked to outcomes of improved water quality and river health, maintenance of water quality in estuaries and the GBR lagoon, and many terrestrial processes including biodiversity and microclimate regulation. Hence, the restoration of riparian vegetation cover is increasingly advocated as a key component of regional natural resource management. However, forest restoration is costly (around $20,000/ha), so it is important to ensure that restoration effort optimises the environmental benefits and is monitored to test achievement of water quality targets and environmental goals.

Rivers are characterised by longitudinal, lateral and surface to ground water linkages, set in a matrix of spatial and temporal variability, including varying intensities of deforestation and land-use effects, often differing in different parts of catchments (Figure 1), as well as extreme hydrological variation due to the generally very high, but seasonal, rainfall. Complex interactions among these factors must be considered in planning for development, conservation and rehabilitation. Frameworks that achieve integrated management are rare, and there is presently no clear set of guidelines on what might constitute “best practice” in integrated catchment management in the Wet Tropics. Major issues are usually considered individually as isolated programs of research or action (e.g. riparian restoration, water quality management, environmental flows) and outcomes for a catchment may be fragmented and inadequate to protect the component ecosystems.

***Methods***
This task will produce take inputs from Tasks 1-3, access recent research results (including previous CRC research) and management guidelines and collect relevant new data on aquatic plants (with Task 3), riparian health (with Task 1) and performance of previous restoration works to create an integrated catchment management case study. The study will: (i) determine priorities for conservation of stream reaches that are performing well; (ii) determine priorities for restoration works to ensure most cost-effective use of resources allocated for restoration and rehabilitation; and (iii) determine appropriate techniques for restoration of river banks, riparian vegetation, instream habitat and connectivity, and water quality. The project will focus on representative catchments that are identified as important to coastal marine habitats, and which lie upstream from monitoring sites used in Task 5 – for example, the Russell-Mulgrave, Johnstone and/or Mossman-Daintree.

***Outputs***
We will produce (i) a framework for integrated catchment management to enhance biophysical values of catchments and the quality of water delivered to coastal marine

ecosystems; and (ii) a manual of best practice protocols for planning conservation and restoration of riparian vegetation at the catchment scale in the Wet Tropics.

## Task 5. New tools for the detection of sublethal stress in aquatic organisms exposed to elevated levels of nutrients tection of sublethal stress in aquatic organisms exposed to elevated levels of nutrients

***Rationale***

Traditional monitoring techniques can be inefficient (slow) and ineffective (low statistical power) ways of detecting environmental impacts on aquatic populations, especially when changes are subtle and/or mixed with other sources of variability (see Rationale to Task 6). The current public debate about water quality in the GBR World Heritage Area demands more sensitive and unambiguous indicators of environmental quality. The purpose of this task is to develop new biochemical indicators of sublethal stress based on the principle that physiological stress develops in organisms long before external conditions become so bad that there are measurable responses at the level of whole organisms (death, disease), populations (changes in abundance), or communities (changes in species composition). Some stress biomarkers have been proven for marine organisms, particularly fish from the temperate zone, but little comparable work has been done on tropical aquatic organisms. Once validated, these new tools will be applied to extensive condition and trend analyses in coastal marine communities along the coast of northern Queensland (Task 6).

***Methods***

Physiological stress is best identified by a suite of biomarkers rather than a single test. A number of techniques are available for known cellular functions, but most have not been tested in the local environment. Consequently, one aim will be to evaluate the efficacy of known biomarkers for tropical organisms, while a second aim will be to explore new tools. In both cases, the first step will be laboratory demonstrations of effect, and sensitivity analyses. The second step will be validation of these tools in realistic field tests, comparing condition between organisms living in coastal receiving waters adjacent to impacted and “pristine” catchments by piggybacking on cruises arranged by CRC Reef. The final step, after iterations between laboratory and field, will be optimisation of a package of the most sensitive and cost-effective tools suitable for rapid assessments of condition. We envision separate student projects covering corals, macroalgae and seagrasses. This multi-strand strategy should simultaneously reduce the risk of failing to develop appropriate tools and increase the statistical power of the final package.

A similar approach will be followed to develop passive in-situ samplers capable of monitoring the levels of nutrients (nitrogen and phosphorus species) in estuarine and coastal waters. Potential tools include DET (Diffusive Equilibration in Thin Films) devices for measurement of nitrate, nitrite and ammonia and DGT (Diffusive Gradient in Thin Films) devices for phosphate. Prototypes of the latter are available. The challenge will be to develop sufficiently low detection limits and ways of managing biofouling. DET devices are potentially more challenging because they do not concentrate the analyte. Furthermore, there may be a need to account for biologically-mediated transformations among the different nitrogen species during the extended deployments of passive samplers. The high risk in DET devices is balanced by the greater certainty of producing workable DGT devices. After validation, these tools will link the assessments of organismal condition with exposure to varying levels of nutrients.

***Outputs***

Outputs will include (i) new tools for rapid assessments of sublethal stress in tropical aquatic organisms (corals, macroalgae, seagrasses) and (ii) new, more cost-effective tools for assessing relative and absolute levels of key nutrients in the marine environment. The development and validation of these tools will be the precursor to extensive condition

assessments linked with exposure to excess nutrients (Task 6). Since concern about deterioration of the coastal zone is a global phenomenon, new tools for rapid assessments of condition and trend have great potential to become exports from the Knowledge Country.

## Task 6. Condition and trend assessments for coastal marine communities.

***Rationale***

Coastal marine systems, including coral reefs and seagrass beds within 20 km of the coast, are most at risk from the consequences of changing land use in adjacent catchments. These systems are naturally dynamic because they are subject to multiple stressors including floods, coral bleaching, cyclones, fishing, and crown-of-thorns starfish. The confounding of these many variables is the main reason why conventional monitoring has little likelihood of ever detecting chronic impacts from poor water quality; quite apart from the fact that there is no established monitoring in the tropical coastal zone other than community-based monitoring of seagrass abundance at two locations.

Despite their importance to biodiversity and sustainable fisheries, there is little information about the current condition of coastal marine communities. Most monitoring effort in the Great Barrier Reef is invested in offshore systems, beyond land-based influences. We believe that there is an immediate need to assess the current condition of coastal reefs and seagrass meadows as a precursor to gaining stakeholder acceptance for the difficult changes that will be required should there be a demonstrable need to limit the export of nutrients into coastal receiving waters. We believe that the biomarkers of sublethal stress to be developed in Task 5 provide the best chance for providing the necessary proof that land-based practices must change.

***Methods***

We propose to undertake regular cruises in wet and dry seasons in each of the three years. Initially, our effort will be concentrated in two places: the Wet Tropics coast between Ingham and Cairns, where the major land uses are urban and agriculture, and the GBR north of Cooktown, where the major land uses are cattle grazing and national park. In both areas, key biota will be collected for condition analysis using biomarkers for sublethal stress. In the case of marine plants (seagrass, macroalgae), additional performance measures will be available including PAM fluorometry and tissue nutrient content. One example of the latter will be the use of stable isotope analysis to compare the proportions of tissue nitrogen (N15) derived from terrestrial and marine sources.

The field validation phase of the previous task (development of new tools) will in effect produce the first quantitative assessments of condition between impacted and reference areas along the inshore margins of the GBR World Heritage Area. Assuming that measurable differences will be detected, the most sensitive biomarkers will be used to make more extensive surveys along the coastline to establish a baseline for monitoring future change (improvement as well as deterioration). Such a baseline survey can also be expected to reveal hotspots of stress that will focus future activities.

Although progress will be determined to some extent by the length of the tools development phase, it is our clear intention to sample multiple locations in at least two consecutive years to demonstrate the stability (or otherwise) of the spatial patterns in condition. The discovery of stable differences will represent the start of trend analysis. It will also provide essential “proof of concept” that can justify more extensive investment in long-term monitoring, especially in areas adjacent to experimental catchments manipulated to reduce the export of nutrients.

***Outputs***

Outputs will include (i) spatial assessments of current condition in reef corals, macroalgae and seagrasses along the inshore fringe of the GBR World Heritage Area, (ii) identification of

the most impacted areas to serve as focal sites for more intensive studies of process, (iii) trend analysis for selected sites, (iv) baseline data for long-term monitoring, and (v) immediate contribution of quantitative data on the ecological health of key marine ecosystems to inform the important public debate about the level of threat from land-based activities to the integrity of coastal marine ecosystems.

## Task 7. Achieving outcomes: adoption of tools through training of the current and new generation of practitioners.

***Rationale***
An essential component of this proposal is conversion of the project outputs into outcomes. While the immediate research outputs are likely to be adopted by relevant agencies and practitioners, successful broad-scale adoption will require a proactive and coordinated approach. This will be facilitated by a program of capacity building, which will involve specific training activities (see section on Education and Training) within the university partners, and project-specific activities.

***Methods***
Task-specific activities will include technical workshops involving researchers and interested parties (management agencies, practitioners, etc.) to advise on research directions and development and adoption of outputs. Workshops on appropriately combined tasks or themes will be arranged soon after commencement of this program, and towards the final stages when manuals and other outputs are being developed. Development of the tasks and delivery of the outcomes will involve regular consultation with relevant parties, possibly through a Program Advisory Committee mechanism. It is envisaged that this knowledge-brokering will be facilitated by a coordinator appointed specifically for this task.

***Outputs***
This task will enhance outputs from Task 1-6, and will expedite integration and adoption of the outputs. It will provide an important forum for the assessment of relationships between land-based activities, riparian zone functions, river water quality delivered to the coast and the ecological condition of reef and seagrass ecosystems.

***Postgraduate training***
It is intended to fund postgraduate projects through the proposed program. This will provide first-hand experience of the issues and their solutions to a new cohort of highly trained professionals, at the same time as contributing to the research goals of the project. This is currently a very successful strategy of both Rainforest and Reef CRCs.

Both CRCs have a large cadre of postgraduate students. Most of these students, on completion of their research, take up positions in the CRC partner institutions or industries. However, as in most research fields there is a strong “silo” effect with marine researchers understanding little of what happens in rainforests or elsewhere on land and vice-versa. It is clear that there is a lack of young research-trained professionals working in many of these institutions and industries who can address such cross-ecosystem issues. In order to address this critical problem we will be funding five new postgraduate research scholarships on the Catchment to Reef Program with a clear goal being to ensure that these new professionals have an understanding of the issues from source to sea and that they develop the expertise needed to address these cross-ecosystem problems and management solutions.

***Community Education***
In most CRCs, particularly the environmental sector CRCs, there has been a recent and dramatic shift in the way researchers work with stakeholders in designing and managing

research projects and disseminating research results to the broader community. Both Reef and Rainforest CRCs have been at the forefront of this field through the development of their Task Review Strategy (Reef CRC) and Program Support Groups (Rainforest CRC). Both CRCs have invested heavily in key appointments of "knowledge brokers" or "knowledge facilitators" in areas such as indigenous involvement, vegetation management, and tourism.

In the Catchment to Reef Research Program we have created a separate Task 7 to target the training of current and new generations of practitioners and managers. This Task will involve knowledge brokering with a wide range of stakeholders and an appointment will be made to facilitate this. This appointee will facilitate research integration, interactive workshops and other communication strategies involving multiple stakeholders.

***Training workshops***

Agencies and practitioners will be involved in workshops to develop the research tasks, and to develop formats for documenting and disseminating their outputs. These workshops will greatly enhance understanding of the research and its values, and will facilitate adoption of improved techniques and protocols. Subject to demand, technical training will be offered to provide practitioners and agency staff with the skills they need to put the new tools into practice (see Task 7 of Research Plan).

There will also be a significant need to extend the information to the community regional NRM groups and this may require substantial adaptation of outputs to a non-technical level. There will be a clear need for this as these groups will be responsible for determining the investment of funds for remedial and restoration activities. Innovative tools (e.g. interactive Web sites, dynamic conceptual pathway software) developed for this purpose could also assist in developing a greater awareness of the issues in the general public arena.

# APPENDIX 4.
# THEMES FOR DISCUSSION GROUPS

1. ***Comments on the research plan***
   The plan set out to address perceived needs, namely to develop cost-effective tools to facilitate monitoring and assessment of health of aquatic ecosystems and performance of improved management initiatives. It has a three-year life span under current funding arrangements.

2. ***Standardising methods***
   Methods for ecosystem health assessment, water quality monitoring, etc. vary from lab to lab and agency to agency. The program aims to identify preferred methods, but in the meantime, how do we ensure comparability of data between current and new initiatives? Is the focus needed at the lab or the institutional level?

3. ***Sharing data***
   Substantial value-adding of limited data sets can be achieved by appropriate data-sharing agreements. How can this ideal be achieved? Is the focus needed at the lab or the institutional level?

4. ***Shared sites and complementary sites***
   Shared sites facilitate comparability between different programs and add value where different types of data are being collected; and where similar data are being collected, it is possible to increase the number of sites, improving the value of the overall dataset. How do we develop a network of such sites? Is the focus needed at the lab or the institutional level?

5. ***Expected outputs and how to achieve them***
   What outputs should we expect from the program – thematic reports, training manuals, best practice guidelines, cookbook approaches (suggest style, content); databases; scientific papers; workshops and their reports; trained personnel through targeted training (in what?); post-graduate students (what specialisations?); other?

6. ***Desirable outcomes and how to achieve them***
   Adoption and application of the outputs is the intended outcome of the program: how do we achieve these goals?

7. ***Other themes***
   Your group may decide that some other burning issue needs discussion and subsequent consideration by the research team.