



**Australian Government**

**Department of the Environment, Water, Heritage and the Arts**

## **Marine and Tropical Sciences Research Facility Milestone Report, December 2008**

**Program 7: Halting and Reversing the Decline of Water Quality**

**Project 3.7.3: Freshwater indicators and thresholds of concern**

**Project Leaders: Professor Richard Pearson, James Cook University  
Professor Angela Arthington, Griffith University**

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### **Summary**

This report covers activities undertaken by the three collaborating organisations – James Cook University, Griffith University and CSIRO – since the June 2008 milestone. It addresses the relevant milestones and objectives detailed in the Project 3.7.3 Research Plan (summarised below). Briefly:

- A field sampling program continued in the Tully-Murray wetlands, with subsequent laboratory work to identify indicators of ecosystem health. The potential of several biological indicators was identified, namely zooplankton, macroinvertebrates and juvenile and small fish.
- Substantial new ecological data are being collected on these special wetlands, providing new insights into the ranges of restricted fish species, the use of lagoons for recruitment, and the apparently overall good condition of the larger lagoons despite agricultural impacts on water quality, weed invasions and habitat decline, especially in riparian zones.
- Presentations on progress in this project were presented to the GBRMPA in Townsville, to an Ecohydrology workshop in Cairns and at several other venues.
- Additional work was completed in the Mackay-Whitsunday area by a postgraduate student.
- Six postgraduate projects have been associated with this project.
- It must be noted that the team has continued to work, to their long-term benefit, but without their financial support. The team has continued work because of the importance of the issues in the regions, as elucidated in our initial proposal. It is regrettable that none of the NRM Boards have been able to provide even minor funding towards postgraduate projects (although Mackay-Whitsunday has been very helpful in finding in-kind assistance) and that the MTSRF has not been able to leverage such funding.

The project continues as planned.

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## Project Outputs / Milestones

Objective	Targeted Activity	Due Date
(a), (b)	Update biophysical models of the ecological consequences of changes in landscape stressors in the tropics, and proposed biophysical indicators of freshwater ecosystem health.	June 2009
(a)	Test spatial and temporal variability of freshwater indicators in the Tully-Murray catchment – field work.	June 2009
(a)	Subject to supplementary funding, report on preliminary field work and desk-top review of Burdekin system.	Dec 2008
(a)	Complete laboratory work on 2008 samples for the Tully/Murray, refine summary conceptual models and identify key research issues to support development of new or refined indicators.	Feb 2009
(a)	Subject to supplementary funding, report on draft indicators for the Burdekin system.	Dec 2008
(c)	Develop and support postgraduate projects.	Ongoing

The milestone for December 2008 is as follows:

1. Progress update for activities listed against objectives (a)-(d) (above), describing work achieved to date and preliminary research findings; and
2. Plan of communication outputs and products for Year 2 and summary of any liaison activities undertaken to date, including minutes of meetings / workshops if applicable.

## Project Results

### *Description of the results achieved for this milestone*

#### **1. Progress update for activities listed against objectives (a)-(d):**

***Update biophysical models of the ecological consequences of changes in landscape stressors in the tropics, and proposed biophysical indicators of freshwater ecosystem health***

***Test spatial and temporal variability of freshwater indicators in the Tully-Murray catchment – field work***

***Complete laboratory work on 2008 samples for the Tully/Murray, refine summary conceptual models and identify key research issues to support development of new or refined indicators***

Fieldwork has continued in the Tully wetlands to test conceptual models of the ecological functioning of the wetlands and the impacts upon them. The final field trip of the year was completed in early December and the samples are now being processed. Our picture of the ecology of these wetlands is developing, but will depend on bringing together the seasonal information from the whole sampling program during 2008. As a result, we will address our current models and update where necessary, and we will determine appropriate indicators of ecosystem health.

Current results suggest that much of the fauna in the wetlands is resistant to the immense change in land use that has taken place across the floodplain in the last century. Potential indicators such as plankton and benthic invertebrates tend to correlate very closely with habitat changes, which themselves are quite straightforward to monitor (e.g., floods, riparian condition, exotic weeds). Fish appear to provide a more robust indication of overall wetland condition and, importantly, connectivity.

Following completion of laboratory work we will hold a project team workshop (partly in conjunction with Project 3.7.4) to assess the results and to determine future directions.

***Subject to supplementary funding, report on preliminary field work and desk-top review of Burdekin system***

***Subject to supplementary funding, report on draft indicators for the Burdekin system***

We sought a partnership with the Burdekin Dry Tropics NRM Board but, despite investment in workshops and meetings, which were apparently well received by BDTNRM, nothing useful for MTSRF eventuated. However, postgraduate projects have enabled us to undertake some work in this important region (below).

***Develop and support postgraduate projects***

We have six postgraduate projects currently associated with the program:

- **Paul Godfrey (PhD):** *Influence of flow seasonality on the recruitment ecology of riverine fishes from lowland Wet Tropics rivers.* Thesis due November 2009.

This project commenced as part of the Catchment to Reef Joint Program between the Rainforest CRC and CRC Reef, and is currently being supported by the MTSRF through Paul's involvement with Project 3.7.3. Paul has demonstrated the relationship between the structure and dynamics of the larval fish assemblage in lowland riverine habitats and the underlying variability of the habitat and its condition that is shaped primarily by the prevailing flow regime. The understanding of fish recruitment dynamics in riverine systems and the taxonomic experience gained through this PhD had been applied to Project 3.7.3 in the testing of conceptual models of the ecological functioning of the Tully-Murray wetlands and the impacts upon them.

- **Carrie Preite (PhD):** *Phytoplankton Dynamics of Riverine Water Holes in the Dry Tropics of North Queensland, Australia.* Thesis submitted.

Carrie's project commenced in parallel with the MTSRF project, and is included in this report because of the support from MTSRF researchers (Pearson, ACTFR), its close connection with the goals of the MTSRF program, its filling of a gap not otherwise supported, and its links to the following project. Her thesis has recently been submitted. In it, Carrie demonstrates the close connection between phytoplankton community structure and dynamics and the underlying variability of the habitat, whether due to natural or human influences. While the phytoplankton closely represents the status of ecosystem health, its utility in monitoring is limited by our restricted knowledge of cause-effect relationships and because of the time-consuming nature of sample processing.

- **Melanie Blanchette (PhD):** *Dynamics of macroinvertebrate assemblages and trophic relationships in dry tropical rivers of the Upper Burdekin catchment.* Thesis due 2010.

This project parallels the previous one in that it is examining ecological dynamics in the Burdekin system, this time focussing on macroinvertebrates – the key group of animals in most biomonitoring of freshwater systems. Whether communities are random or highly structured in their assembly, especially after floods and during droughts, is very important to understanding their utility as indicators of health. For this purpose they are relatively utility as monitors. The project will also examine food web dynamics, linking processes to the ecosystem health of the system.

- **Katherine Leonard (1) (MAppSci):** *Macroinvertebrates as indicators of streams ecosystem health in the Mackay-Whitsunday region.* Dissertation completed.

This project was undertaken in collaboration with the Mackay-Whitsunday NRM Board, although without any funding from that source. It found that invertebrates were very useful in indicating health of streams, but that health was largely represented by habitat structure rather than water quality. Thus, the impacts of agriculture included substantial loss of riparian vegetation and concomitant invasion by exotic weeds, which led to substantial changes in the invertebrate communities. The work will inform the MWNRMB Board and allow it to determine whether to include stream invertebrates in its future monitoring program.

- **Katherine Leonard (2) (PhD):** *Testing indicators of ecosystem health in Wet Tropics streams.* Thesis due 2011.

Following completion of her Masters (above, Katie commenced this project in August 2008. The first task has been to review health issues, and these have been set in the context of climate change. This review will be completed shortly and made available as a short paper. Its outcome will be to determine the subsequent course of the project.

- **Michael Ellison (GradDip):** *Testing indicators of ecosystem health in Wet Tropics wetlands.* Dissertation due mid-December.

This short project is based on the first series of samples in the MTSRF project. Michael has assisted in the project, and has extended the amount of work possible. His analyses, comparing different indicators, will provide a basis for our subsequent assessment of the results of our whole sampling program.

- **Stephanie Januchowski (PhD):** *Conservation Planning for Streams in the Wet Tropics Bioregion.* Thesis due 2010.

This project is developing a classification of streams of the Wet Tropics in relation to their biophysical features and human influences upon them, as a means of developing conservation planning tools, such as conservation prioritisation. The classification will allow projections from known distributions of animals and plants across the whole data-sparse region. Ground-truthing of predictive models will be undertaken to check their robustness, and to contribute to an assessment of the data needs in regions where the level of biological inventory is limited.

## 2. Plan of communication outputs and products for Year 2 and summary of any liaison activities undertaken to date, including minutes of meetings / workshops if applicable:

### *Liaison activities, etc., since the last milestone includes:*

- **Angela Arthington** was appointed to the **Environmental Water Scientific Advisory Committee** (DEWHA) to provide advice to the Commonwealth Environmental Water holder on how to manage the Commonwealth's water holdings to protect and restore the environmental assets of the Murray-Darling Basin and other Australian rivers.
- **Angela Arthington, Richard Pearson** and **Paul Godfrey** attended an Ecohydrology Science Workshop, in Cairns, 21 November 2008. Arthington and Pearson gave presentations (see *Presentations* below).
- **Richard Pearson** and **Katie Leonard** attended an international workshop on climate change, Cape Tribulation, 17-20 November 2008.

### **Presentations**

Arthington, A.H. (2008) *Water scarcity, environmental flows and floodplain ecology*. CERF Conference, 16 September 2008, Canberra.

Arthington, A.H., Pearson, R.G., Godfrey, P. and Wallace J. (2008) *Hydro-ecological relationships from source to sea: floodplain processes*. Ecohydrology Workshop, 21 November 2008, Cairns.

Januchowski, S.R., VanDerWal, J., Pressey, R.L., Pearson, R.G. and Thomas, C. (2008) *Towards Regional Stream Classification: Wet Tropics Region Case Study*. Ecological Society of Australia Annual Meeting, December 2008, Sydney.

Pearson, R.G. (2008) *Song of the platypus – Climate, streams and the rainforest-to-reef continuum*. Keynote address to the 2008 Australian Festival of Chamber Music, 8 July 2008, Townsville.

Pearson, R.G. (2008) *Catchment to reef – Water links in the landscape*. Talk to Siemens Science students, 30 September 2008, Townsville.

Pearson, R.G. (2008) *Life in the fast stream: A natural history of wet tropics rivers*. Public Lecture, 22 October 2008, Cairns.

Pearson, R.G. (2008) *Biodiversity and flow in Wet Tropics streams*. Ecohydrology Workshop, 21 November 2008, Cairns.

Pearson, R.G., Arthington A.H. and Wallace J. (2008) *Key drivers of wetland health – Land use, water quality, connectivity and habitats*. Presentation to the Great Barrier Reef Marine Park Authority, 23 July 2008, Townsville.

### **Other relevant publications**

Balcombe, S.R. and Arthington, A.H. (In press) Temporal changes in fish abundance in response to hydrological variability in a dryland floodplain river. *Marine and Freshwater Research*.

Bastian, M., Pearson, R.G. and Boyero, L. (2008) Effects of diversity loss on ecosystem function across trophic levels and ecosystems: A test in a detritus-based tropical food web. *Austral Ecology* 33: 301-306.

Bond, N.R., Lake, P.S. and Arthington, A.H. (2008) The impacts of drought on freshwater ecosystems: An Australian perspective. *Hydrobiologia* 600(1): 3-16.

Boyero L., Ramírez, A., Dudgeon, D. and Pearson, R.G. (In press) Are tropical streams ecologically different? *J. N. Am. Benth. Soc.*

Camacho R., Boyero, L., Cornejo, A., Ibáñez, A. and Pearson, R.G. (In press) Local variation in shredder distribution can explain their oversight in tropical streams. *Biotropica*.

Fryirs, K., Arthington, A. and Grove, J. (2008) Principles of River Condition Assessment. In: Brierley, G.J. and Fryirs, K.A. (eds.) *River Futures: An Integrative Scientific Approach to River Repair*. Island Press, Washington DC, pp. 100-118.

Likens, G., Walker, K., Davies, P., Brookes, J., Olley, J., Young, B., Thoms, M., Lake, S., Gawne, B., Davis, J., Arthington, A.H., Thompson, R., Oliver, R. and Doolan, J. (In press) Ecosystem science: a paradigm shift for managing Australia's aquatic resources. *Marine and Freshwater Research*.

Medeiros, S.E.F. and Arthington, A.H. (2008) Diet variation in food intake and diet composition of three native fish species in floodplain lagoons of the Macintyre River, Australia. *J. Fish Biology* 73 (4): 1024-1032.

Medeiros, S.E.F. and Arthington, A.H. (2008) The importance of zooplankton in the diets of three native fish species in floodplain waterholes of a dryland river, the Macintyre River, Australia. *Hydrobiologia* 614: 19-31.

Pearson R.G. and Boyero, L. (In press) Gradients in regional diversity of freshwater taxa. *J. N. Am. Benth. Soc.*

Perna C. and Pearson, R.G. (2008) Temporal dynamics of fish assemblages in small seasonal streams in the Queensland tropics. *Australian Journal of Zoology* 56: 65-73.

Pusey, B.J., Kennard, M.J. and Arthington, A.H. (2008) Origins and maintenance of freshwater fish biodiversity in the Wet Tropics region. Chapter 9. In: *Living in a Dynamic Tropical Forest Landscape*. N.E. Stork and S.M. Turton (eds.) Wiley-Blackwell Publishing, Oxford, United Kingdom, pp. 150-160.

Rayner, T.S., Pusey, B.J. and Pearson, R.G. (2008) Seasonal flooding, instream habitat structure and fish assemblages in the Mulgrave River, north-east Queensland: Towards a new conceptual framework for understanding fish-habitat dynamics in small tropical rivers. *Marine and Freshwater Research* 59: 97-116.

Rayner, T.S., Pusey, B.J. and Pearson, R.G. (In press) Spatio-temporal dynamics of fish feeding in the lower Mulgrave River, north-eastern Queensland: The influence of seasonal flooding, instream productivity and invertebrate abundance. *Marine and Freshwater Research*.

Thuesen, P.A., Pusey, B.J., Peck, D.R., Pearson, R.G. and Congdon, B.C. (2008) Genetic differentiation over small spatial scales in the absence of physical barriers in an Australian rainforest stream fish. *Journal of Fish Biology* 72: 1174-1187.

Yule, C.M., Yi Leong, M., Cheng Liew, K., Ratnarajah, L., Schmidt, K., Ming Wong, H., Pearson, R.G. and Boyero L. (In press) Do altitudinal gradients in species richness explain the apparent scarcity of shredders in tropical streams? *J. N. Am. Benth. Soc.*