

**Marine and Tropical Sciences Research Facility (MTSRF)
June 2008 Milestone Report**

Project 3.7.3 – Freshwater indicators and thresholds of concern.

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Summary

Summary of Milestone report

This report covers activities undertaken by the three collaborating organisations – James Cook University, Griffith University and CSIRO, mostly in the two months since the last milestone. Most details reported in the last milestone are not repeated.

This report 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 potential indicators of ecosystem health. The potential of several biological indicators was identified, namely zooplankton, macroinvertebrates and juvenile and small fish.

A presentation on progress in this project was presented to the MTSRF conference in Cairns.

Additional work continued in the Mackay-Whitsunday area.

Three PhD students and one Diploma/Masters student have commenced their research, or will do so in the near future.

The research team had several project meetings through the past year. Members of the team held various meetings with stakeholders, gave several presentations on the project, provided advice to relevant committees and responded to requests for information from RRRC and other organisations.

Milestones

The milestones for June 2008 and progress towards them are as follows.

1. Report on testing of indicators in the Tully system and identification of possible spatial and temporal thresholds of potential concern in Wet Tropics waterways: description and interpretation of preliminary findings [JCU]
2. Input to report on testing of indicators in the Tully systems and identification of possible spatial and temporal thresholds of potential concern in Wet Tropics waterways [GU].

Project Results

Following the pilot studies of the wetlands of the Tully-Murray floodplain, reported previously, the substantive sampling program commenced. We aimed to sample up to twelve remnant lagoons three or four times during 2008 to capture seasonal changes in water quality and the biota. The intent is to seek gradients in connectivity of the lagoons and agricultural impact on them along which to trace change in potential indicators. This approach may be confounded as simple gradients may not exist, so the design will be treated as multivariate case study that will inform our conceptual models and validate indicator variables.

Choice of lagoons for sampling was constrained by their availability and accessibility. We have aimed to capture the upstream-downstream gradient of the floodplain, which may relate to both connectivity and level of agricultural influence. Lagoons sampled were, in the Murray area, Kyambul, Zamora's, Digman's, Digman's 3, Selby's, Boongaray and Carroll's; and in the Tully area, Raccanello's, Bunta and Barrett's (Figure 1).

The sampling regime is outlined in Table 1. Indicators currently being tested that show promising results include larval fish, zooplankton and benthic invertebrates. Initial assessment indicates that approx 50% of fish known from the Tully-Murray region were identified in the lagoons, including species of regional conservation significance. The predominant species were those that complete their entire life cycle in the lagoon, indicating the importance of the remaining floodplain wetlands in the GBR catchment. Laboratory work on the plankton and macroinvertebrates is progressing, and water samples are with the relevant analytical laboratories.

Analysis of possible thresholds of concern is not yet practical until the sampling program is completed.

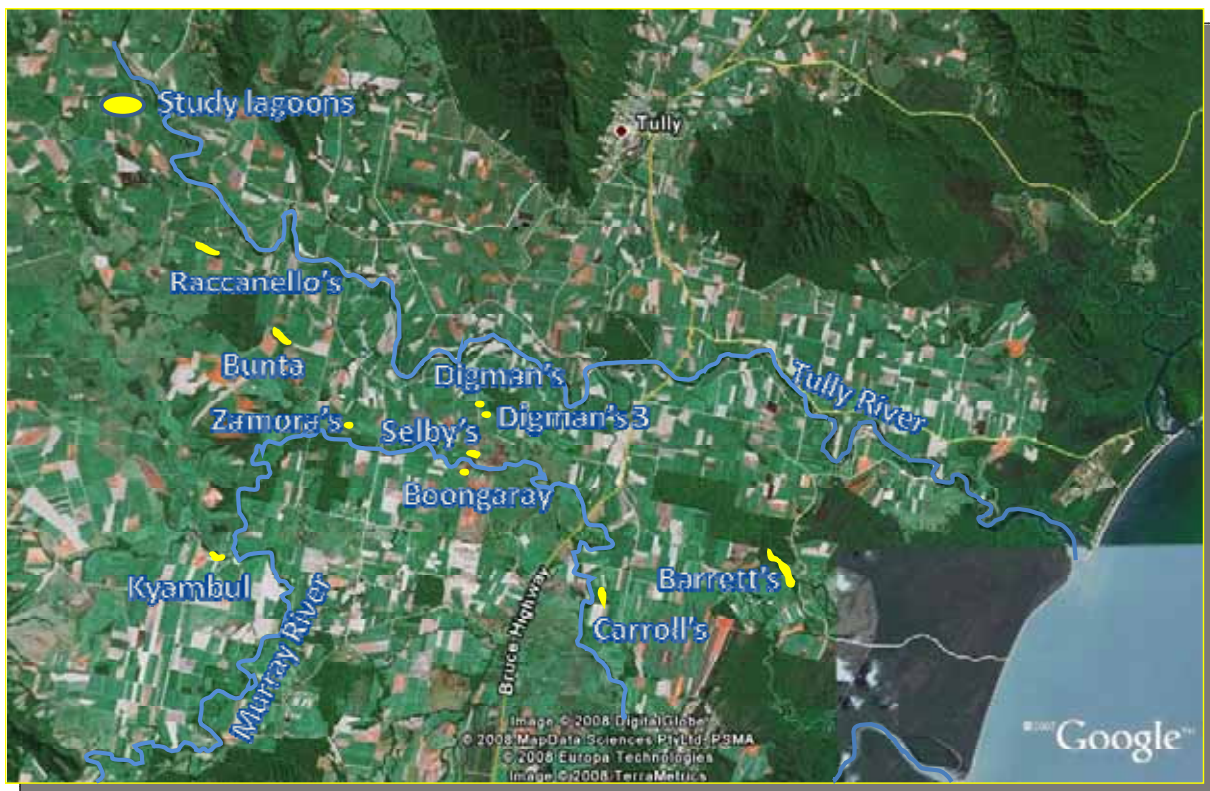


Figure 1. Location of sampling sites, Tully-Murray floodplain

Table 1. Sampling program, Tully-Murray lagoons, May 2008

Component	Variable	Sampling approach
Water quality	Physical: temperature, conductivity, dissolved oxygen, transparency, pH	One transect per site perpendicular from bank to mid channel. Readings at lagoon edge, 1m, 4m and mid-channel, each at 1m depth intervals
	Nutrients (N and P species) and chl-a	Replicated edge and mid-channel water samples
	Herbicides (LCMS)	One composite water sample per lagoon.
Aquatic habitat	Estimate of % cover of macrophytes, leaf litter and large woody debris per transect.	One 10 m transect for both left & right bank at each site within each lagoon.
Littoral macro-invertebrates	Emergent macrophyte	Three 0.5-m ² replicates collected from emergent macrophyte in each site in each lagoon.
	Submerged macrophyte	Where present, three 0.5 m ² replicates collected from submerged macrophyte in each site in each lagoon.
	Leaf litter	Where present, three 0.5 m ² replicates collected from leaf litter in each site
Zooplankton	Surface	Two x three-minute plankton tows at two sites within each lagoon
	1.5m	Two x three-minute plankton tows at two sites within each lagoon
Fish - fyke netting	Lagoon edge	Two pairs of nets positioned around the edge of each lagoon, where feasible.
	Inlet channel	One pair of nets located in the inlet channel of each lagoon, where feasible.
	Outlet channel	One pair of nets located in the inlet channel of all three lagoons facing up- and downstream, where feasible.
Fish - electrofishing	Emergent macrophyte	10 x 30-second electrofishing shots amongst emergent macrophyte; pooled across the entire lagoon.
	Submerged macrophyte	Where present, 10 x 30-second electrofishing shots amongst submerged macrophyte that was pooled across the entire lagoon.
	Leaf litter	Where present, 10 x 30-second electrofishing shots amongst leaf litter that was pooled across the entire lagoon.

Summary of liaison activities undertaken through course of Year 2 of project in collaboration with GU [JCU].

a. Publication of Catchment to Reef Products

Arthington A.H and Pearson R.G. (Eds) 2007. Biological indicators of ecosystem health in Wet Tropics streams. Chapters are:

- 1. Arthington A.H., Connolly N.M. and Pearson R.G. Introduction: the *Catchment to Reef* Program and Stream Health Monitoring.
- 2. Connolly N.M, Pearson B.A., Loong D., Maughan M. and Pearson R.G. Hydrology, Geomorphology and Water Quality of Four Wet Tropics Streams with Contrasting Land-use Management.
- 3. Mackay, S.M., James, C. and Arthington, A.H. Aquatic Macrophytes as Indicators of Catchment Land-use and Water Quality in Wet Tropics Streams.
- 4. Connolly N.M, Pearson B.A. and Pearson R.G. Macroinvertebrates as Indicators of Ecosystem Health in Wet Tropics Streams.
- 5. Pusey, B.J., Kennard, M.J. and Arthington, A.H. Freshwater Fish as Indicators of Ecosystem Health in Wet Tropics Streams.
- 6. Pearson R.G, Arthington, A.H., Connolly N.M., Mackay S.J. and Pusey B.J. Summary and synthesis: integrated protocols for monitoring the ecosystem health of Australian Wet Tropics streams.

b. Other relevant publications

Bastian, M., L. Boyero, B.R. Jackes & R.G. Pearson 2007. Leaf litter diversity and shredder preferences in an Australian tropical rain-forest stream. *J. Tropical Ecology* 23:219-229.

Bastian, M., R.G. Pearson & L. Boyero 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.

Boulton AJ, Boyero L, Covich AP, Dobson MK, Lake PS, Pearson RG, 2008. *Are tropical streams ecologically different from temperate streams?* Chapter 9 In: *Tropical Stream Ecology* (Ed. Dudgeon D), Academic Press, San Diego (Aquatic Ecology Series), pp. 257-284.

Boyero L, Pearson RG, Bastian M. 2007. How biological diversity influences ecosystem function: the separate role of species richness and evenness. *Ecological Research* 22: 551-558.

Boyero L., P.A Rincón. and R. G. Pearson 2008. Effects of a predatory fish on a tropical detritus-based food web *Ecological Research* DOI 10.1007/s11284-007-0424-6 (in press).

Connolly N.M. and Pearson R.G. 2007. The effect of fine sedimentation on tropical stream macroinvertebrate assemblages: a comparison using flow-through artificial stream channels and recirculating mesocosms. *Hydrobiologia* 592: 423-438.

- Connolly N.M., Christidis F., McKie B., Boyero L. and Pearson R.G. 2008. *Diversity of invertebrates in Wet Tropics streams: patterns and processes*. Chapter 12 in Stork N.E and Turton S. (eds) *Living in a Dynamic Tropical Forest Landscape*. Blackwells Publishing (in press).
- Økelsrud A. and Pearson R.G. 2007. Acute and post-exposure effects of ammonia toxicity to juvenile barramundi (*Lates calcarifer* [Bloch]). *Archives of Environmental Contamination and Toxicology* (in press – acc 6/5/07). 53, 624–631.
- Pearson R.G & Stork N.E. 2008. *Catchment to Reef: Water Quality and Ecosystem Health In Tropical Streams*. Chapter 45 in Stork N and Turton S (eds) *Living in a Dynamic Tropical Forest Landscape*. Blackwells Publishing (in press).
- Perna C. and R.G. Pearson 2008. Temporal dynamics of fish assemblages in small seasonal streams in the Queensland tropics. *Australian Journal of Zoology* (in press).
- Pusey B., Kennard, M. and Arthington, A. 2008. *Origins and maintenance of freshwater fish biodiversity in the Wet Tropics region*. Chapter 11 in Stork N and Turton S (eds) *Living in a Dynamic Tropical Forest Landscape*. Blackwells Publishing (in press).
- Rayner T.S., Pusey B.J and Pearson R.G. 2008. Spatial and temporal variability in fish–habitat relationships in the lower Mulgrave River, north-eastern Queensland. *Marine and Freshwater Research* (in press).
- Rayner T.S., Pusey B.J. & 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
- 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.

c. Meetings etc

- Liaison activities undertaken year 2, 2007-2008
- Cardwell Shire meeting and Tully field work, June (RP, AA, JW)
- Cardwell Shire workshop (BAT), Tully, July (RP)
- Burdekin Dry tropics preliminary meeting, August (RP, S.Morris)
- Mackay Whitsunday meeting and field work August (RP)
- Meeting with GBRMPA representative (D.Haynes), August (RP)
- Mackay-Whitsunday field trip September (RP)
- Burdekin Water Quality Improvement Plan Link Up Workshop, September (RP)
- Reef Water Quality Partnership Integration Workshop, September (RP)

- Burdekin Dry tropics preliminary workshop, October (RP, S.Morris)
- Burdekin Water Quality Improvement Plan High Ecological Values Workshop, October (RP)
- Project 3.7.3-3.7.4 Planning workshop, October (RP, AA, JW et al.)
- Reef Partnership SAP meeting, Brisbane, November (RP)
- NRW Wet Tropics monitoring meeting, Brisbane, November (RP)
- NRW Wet Tropics ecological models workshop for SEAP program (Cairns, November) (RP, AA)
- Numerous relevant interactions (e.g., with TRaCK participants) and delivery of papers at the joint meeting of the New Zealand Freshwater Sciences Society and the Australian Limnological Society, Queenstown NZ, December 2007 (AA, RP)
- Cardwell Shire assistance with fieldwork, December 2007
- CIRM Directors' meeting, January, March, June, 2008 (RP)
- Mackay-Whitsunday workshop, March 2008 (RP)
- Burdekin Dry tropics workshop, January 2008 (AA, RP)
- Project 3.7.3-3.7.4 Planning workshop, February 2008 (RP, AA, JW et al.)
- Project 3.7.3-3.7.4 Planning workshop, March 2008 (RP, AA, JW et al.)
- Reef Partnership Scientific Advisory Committee meetings June, November 2007; March, June 2008 (RP)
- Meeting with D. Haynes (Terrain) regarding monitoring program, June 2008 (RP)
- Liaison with ACTFR regarding pooling of information on the Burdekin system.

d. Other activities

- Appointment of Paul Godfrey (GU) and Regina Camacho (JCU) to assist in Tully-Murray field research program.
- AA and Mark Kennard (Griffith University) attended a "River Science Workshop" presented by The Nature Conservancy (TNC) and the U.S. Geological Survey and in Seattle, Washington, 28-30 April 2008. This workshop explored the frontiers of environmental flows science, especially development of flow alteration-ecological response relationships in rivers and floodplains. A main feature of the Workshop was discussion of the new e-flows method called ELOHA (*Ecological Limits of Hydrologic Alteration*) which has developed out of our recent paper (Arthington *et al.* 2006. *Ecol. App.* 16 (4), 1311-1318).
- AA gave a seminar to engineering and biology students at the University of Queensland, entitled "Do dams damage rivers? How much water does a river need to remain healthy?"

- AA made a submission to the Commonwealth on the Environmental Impact Statement for the proposed Traveston Dam, near Gympie in the Mary River catchment, SE Queensland.
- RP presented project 3.7.3 results at the MTSRF conference in Cairns in April 2008: Pearson, Arthington, Godfrey and Wallace, *Key drivers of wetland health – land use, water quality, connectivity and habitats*

Objectives

The relevant objectives for this reporting period and progress towards them are as follows.

Objective	Targeted Activity to June 2008	Progress
(a)	Contribute expertise and data as required to the Integrated Reporting processes.	Reporting as required; integrated reporting project currently not active
(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	We are meeting regularly and updating our understanding of system function. Currently this is focussed on wet tropics floodplain waterways, which will be reported on completion of field and laboratory work.
(a)	Complete laboratory work on Tully-Murray samples, refine summary conceptual models and identify key research issues to support development of new or refined indicators.	
(a)	Subject to supplementary funding, report on draft indicators for the Burdekin system	Supplementary funding not yet forthcoming, except for an APA scholarship and MTSRF scholarship top-up, supporting a PhD project on ecosystem health in riverine lagoons in the Burdekin catchment.
(c)	Develop concept of Web-based atlases and seek appropriate support to implement them.	We have developed the concept, but need further funding if it is to be developed.
(d)	Develop postgraduate projects	Four current PhD, one Masters and one postgraduate diploma projects have been/are connected with this project.
(e)	Develop end-user-agreed products from the program	We are liaising with several relevant organisations to identify appropriate products and facilitate their adoption, as reported in the previous milestone.

Project Results Summary

Description of the results achieved for this milestone

The program has been successfully completed as expected, although inclement weather at the end of 2006 partly restricted the extent of the field work, such that the first full sampling trip did not take place until May 2008.

Problems and opportunities

Delays due to weather already noted. No support from Burdekin Dry Tropics Board, so sampling program in Burdekin catchment cannot start. However, PhD project in Burdekin has commenced.

Publication of *Catchment to Reef* volume 3 water quality report delayed because of lack of time available.

The supplementary project with the Mackay-Whitsunday NRM is nearing completion. Substantial postgraduate opportunities are being taken up, as indicated above.

Communications, major activities or events

During next milestone reporting period

- Final report on Mackay-Whitsunday study.
- Progress reports on Tully-Murray work.
- Publication of *Catchment to Reef* volume 3 water quality report.
- Publication in scientific literature of *Catchment to Reef* outcomes.
- Continued active involvement in advisory committees, conferences, etc. relevant to the project, as appropriate.
- Continuing liaison with Wallace et al., Project 3.3.4 (e.g. meeting planned for July 18, 2008).