



**Australian Government**

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

**Marine and Tropical Sciences Research Facility (MTSRF)  
March 2007 Milestone Report**

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

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

**Summary**

This report covers activities undertaken by the three collaborating organisations – James Cook University, Griffith University and CSIRO.

Catchment to Reef draft outputs are now on the MTSRF/RRRC web page; print and CD versions are close to completion.

This report addresses the relevant milestones and objectives detailed in the Project 3.7.3 Research Plan (summarised below).

***Briefly:***

A field sampling program commenced in the Tully-Murray wetlands in December 2007, with subsequent laboratory work to identify potential indicators of ecosystem health.

A workshop was held with Burdekin Dry Tropics staff in January 2008 to review the current state of knowledge of aquatic systems in the Burdekin catchment, to develop conceptual models of biophysical processes in Burdekin waterways, and to identify potential partnerships between MTSRF research programs and Board research needs.

Additional work continued in the Mackay-Whitsunday area, extending the geographic reach of the research program.

Paul Godfrey has been offered an appointment at Griffith University (50% of time, 1 January to 30 June 2008) to work on Project 3.7.3 (fish indicators of ecosystem health in floodplain lagoons). Regina Camacho is being employed on the project through James Cook University.

We have pursued the recruitment of postgraduate students. Three PhD students and one Diploma/Masters student have been recruited to the program.

***Milestones and objectives***

The milestones for 2007-2008 Report 2 (March 2008) are:

Report on workshop on biophysical models of the ecological consequences of changes in landscape stressors and proposed suite of biophysical indicators of freshwater ecosystem health in the Dry Tropics: describe models discussed, proposed suite of indicators [JCU].

Input into report on workshop on biophysical models of the ecological consequences of changes in landscape stressors and proposed suite of biophysical indicators of freshwater ecosystem health in the Dry Tropics [GU].

Additionally, we report on a workshop held with the Burdekin Dry Tropics NRM Board that was postponed from December to January and so was not reported on in the previous milestone report.

The relevant objectives for this reporting period are:

<b>Objective</b>	<b>Targeted Activity</b>	<b>Completion Date</b>
(a)	Workshop biophysical models and indicators for Dry Tropics waterways with end users. Develop summary conceptual models and identify knowledge gaps.	January 2008
(a)	Test spatial and temporal variability of freshwater indicators in the Tully-Murray catchment – field work	Dec 2007
(a)	Subject to supplementary funding, report on preliminary field work and desk-top review of Burdekin system	Dec 2007
(d)	Develop postgraduate projects	ongoing
(e)	Develop end-user-agreed products from the program	ongoing

## Progress Update

### **1. Progress update for activities listed against objectives a-e describing work achieved to date, and any preliminary research findings.**

#### **1.1 Workshop biophysical models and indicators for Dry Tropics waterways with end users. Develop summary conceptual models and identify knowledge gaps.**

The workshop planned for December 2007 was held with Burdekin Dry Tropics staff in January 2008 to review the current state of knowledge of aquatic systems in the Burdekin catchment, to develop conceptual models of biophysical processes in Burdekin waterways, and to identify potential partnerships between MTSRF research programs and Board research needs. BDT appeared interested in co-funding research on indicators and thresholds of concern in their next budget round. The workshop provided a broad outline of knowledge and knowledge gaps in the Burdekin system, and identified areas of future research need for improved management. It involved participants from the Burdekin Dry Tropics, MTSRF (James Cook University, including ACTFR; Griffith University; and CSIRO), EPA and NRW. A report is being prepared; the agenda and list of participants are provided as Attachment 1.

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

Pilot field work was undertaken in December 2007 (see summary, Attachment 2). The program includes water quality, zooplankton, macroinvertebrate and fish sampling at major lagoon sites on the floodplain, including the site currently the focus of detailed hydrologic and water quality investigations by CSIRO (J. Wallace, Project 3.7.4). The current rationale is to compare signals from potential indicators with the Cardwell Shire classification of sites according to their ecological values. This test will help us determine likely candidates as indicators, to be subjected to more detailed investigations in 2008. Preliminary multivariate analysis of the Cardwell Shire scores for values and threats provided an understanding of the perceived gradients of ecological integrity of the lagoons with which to compare actual biophysical data.

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

A review on the available information for the Burdekin catchment has progressed, particularly through access to information through the EPA, ACTFR (Burrows, Brodie, Veitch, Perna), Griffith University (Arthington, Pusey), and work at JCU by Pearson and his students. However, as supplementary funding through the BDT is still subject to negotiation, the review is still in its preliminary stages. No field work has commenced. We hope to secure funding from the BDT in 2008.

In the meantime APA funding has been provided for a PhD student who will be working on ecological dynamics of Burdekin riverine waterholes, to provide the science that will underpin indicator development and threshold identification (see below). This will kick-start the research and will help progress the review.

#### **4.4 Develop postgraduate projects**

We have developed a number of postgraduate projects that link with our program as follows:

Food webs in the Mulgrave River (T. Rayner, APA-funded PhD JCU, completed).

Larval recruitment in Wet Tropics rivers (P. Godfrey, CRC-funded PhD GU, continuing).

Testing macroinvertebrates as indicators of ecosystem health in streams of the Mackay-Whitsunday region (K. Leonard, MSc JCU, completing).

Testing indicators in Wet Tropics streams (K. Leonard, MTSRF-funded PhD, JCU, commencing 2008).

Dynamics of flow and ecosystem health in dry tropics rivers (M. Blanchette, APA-funded PhD, JCU).

Framework development for conservation planning for wet tropics waterways (S. Januchowski, Atherton Tablelands PhD, JCU).

Hydrological connectivity, fish diversity and recruitment processes in floodplain lagoons of GBR catchments (GU PhD proposal to MTSRF pending).

#### **5.5 Develop end user agreed products from the program**

The Catchment to Reef River Health Report is currently being printed (draft on Web). We are in discussions with Cardwell Shire with regard to application of our research in their WQIIP program and beyond. We are directly addressing the needs of the Mackay-Whitsunday NRM body through our current research in that region (being undertaken at their request). Discussions with Burdekin Dry Tropics and our workshop in January are designed explicitly to address the needs of the BDT.

## **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.**

Communication outputs and products for Year 2

Publication in print and on the Web of catchment to Reef products:

Arthington A.H. and Pearson R.G. (Editors) Biological Indicators of Ecosystem Health in Wet Tropics Streams. Chapters are:

- Arthington A.H., Connolly N.M. and Pearson R.G. Introduction: the *Catchment to Reef* Program and Stream Health Monitoring.
- 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.
- Mackay, S.M., James, C. and Arthington, A.H. Aquatic Macrophytes as Indicators of Catchment Land-use and Water Quality in Wet Tropics Streams.

- Connolly N.M, Pearson B.A. and Pearson R.G. Macroinvertebrates as Indicators of Ecosystem Health in Wet Tropics Streams.
- Pusey, B.J., Kennard, M.J. and Arthington, A.H. Freshwater Fish as Indicators of Ecosystem Health in Wet Tropics Streams.
- 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.

#### Other relevant publications

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. 2007. *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).

Pearson R.G & Stork N.E. 2007 *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).

Pusey B., Kennard, M. and Arthington, A. 2007. *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. and Pearson R.G. Spatial and temporal variability in fish–habitat relationships in the lower Mulgrave River, north-eastern Queensland. *Journal of Fish Biology* (in press).

#### **Relevant publications in preparation**

- Water quality responses to land use and riparian disturbance in Russell-Mulgrave catchment. (Connolly, RP et al).
- Aquatic plant responses to land use, water quality and riparian disturbance in the Russell-Mulgrave catchment. (Mackay, AA et al).
- Macroinvertebrate responses to land use in the Russell-Mulgrave catchment. (Connolly, RP et al).
- Fish responses to land use, water quality and riparian disturbance in the Russell-Mulgrave catchment. (Pusey, AA et al).
- Herbert River integration Study (RP et al. with CSIRO)
- Factors governing and limiting fish trophic dynamics and dietary partitioning in an Australian wet/dry tropics river (Pusey, AA et al)

Liaison activities undertaken since last milestone

Cardwell Shire assistance with fieldwork, December 2007

CIRM Directors' meeting, January 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, et al.)

Other activities

- Appointment of Paul Godfrey (GU) and Regina Camacho (JCU) to assist in Tully-Murray field research program.
- Liaison with ACTFR regarding pooling of information on the Burdekin system.

## Progress Update

### ***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.

### ***Explanation of Activity changes***

*The workshop with BDT postponed from December 2007 to January 31, 2008, was held as planned .*

### ***Problems and opportunities***

Issues arising have been noted above and arose as a result of inclement weather, or unavailability of BDT staff. Both issues have been addressed satisfactorily. The supplementary project with the Mackay-Whitsunday NRM has continued.

### ***Communications, major activities or events***

#### ***During next milestone reporting period***

Progress reports on Tully-Murray fieldwork and Mackay-Whitsunday fieldwork. Publication of Catchment to Reef volume 3 water quality report.

## Attachment 1

### MTSRF workshop on Dry Tropics Waterway Management: Current Knowledge and Information Needs for Waterway Management

#### Agenda

8.30	Welcome; outline of workshop purpose	R. Pearson
8.45	Introduction to the Burdekin Dry Tropics NRM	S. Crawford
9.15	Current knowledge and activities – waterhole and river ecology	R. Pearson
9.40	Current knowledge and activities – fish and river ecology	B. Pusey
10.05	Current knowledge and activities – terrestrial/aquatic links	J. Wallace
10.30	Morning tea	
10.55	Current knowledge and activities – freshwater/ estuarine interface	M. Sheaves
11.20	Current activities – ACTFR	D. Burrows
11.45	Future directions – ACTFR	B. Butler
12.10	Future directions – MTSRF	A. Arthington
12.35	Discussion – other sources of information (EPA, NRW, DPI, etc)	
1.00	Lunch	
1.45	Discussion – major knowledge gaps and product needs	R. Pearson
2.30	Discussion – conceptual models	R. Pearson
3.15	Afternoon tea	
3.30	Discussion – future research directions	A. Arthington
4.15	Close	

#### Participants

- Prof Angela Arthington (Griffith Uni)
- Melanie Blanchette (JCU postgrad)
- Dr Damien Burrows (ACTFR/JCU)
- Barry Butler (ACTFR/JCU)
- Niall Connolly (EPA)
- Scott Crawford (BDT)
- Ian Dight (BDT)
- Paul Duncanson (BDT)
- Paul Godfrey (Griffith Uni)
- Diana O'Donnell (BDT)
- Prof Richard Pearson (JCU)
- Dr Brad Pusey (Griffith Uni)
- Dr Marcus Sheaves (JCU)
- Peter Verwey (QNRW)
- Dr Jim Wallace (CSIRO)



## Attachment 2

### ***MTSRF Project 3.7.3: Report on Tully-Murray wetlands site inspection and trial of sampling methods, December 2007.***

#### ***Objective***

To trial a range of fish and invertebrate sampling methods within wetland ecosystems and assess their suitability to achieve the objectives of MTSRF Project 3.7.3. This project is confined to the freshwater wetlands on the Tully-Murray river floodplain and focuses on measuring attributes of the fish and invertebrate assemblage in developing ecological indicators of wetland ecosystem health. A site inspection will initially eliminate those wetlands which are difficult to access by vehicle and boat prior to the trial of multiple sampling methods.

#### ***Site inspection***

Fourteen wetlands within the Tully-Murray river system were inspected on 5 December 2007 and their suitability as wetlands to trial the sampling methods was assessed using the following criteria (Table 1):

- accessibility during the wet season including boat access in/onto the wetland during the wet season,
- presence of comparable wetlands that were similar in size and habitat type allowing the same sampling methods to be repeated among wetlands, and
- a range of wetlands that covers a gradient of habitat and connectivity disturbance that allows for a test of these effects on the assemblage structure and function of the wetland biota.

**Table 1:** Wetlands of the Tully-Murray catchments inspected on 5 December 2007.

<b>Wetland name and size* (m2)</b>	<b>Vehicle access</b>	<b>Boat access</b>	<b>Connectivity with surrounding waterbodies</b>	<b>Habitat diversity</b>	<b>Suitability as study wetland</b>
Barrett's Lagoon (765216)	Public access via gazetted rd	Existing boat ramp	Joins Tully River 2 km downstream via a permanently flowing creek	High: deep pools, shallow littoral	<u>High</u> : good access, comparable habitats
Tully River Oxbow (302113)	Requires landholder approval	Limited boat access	Intermittent creek connects Oxbow with Tully River	Low: monotonous habitat - pool choked with instream vegetation	<u>Low</u> : limited boat access and low habitat diversity
Boongaray Lagoon (30173)	Requires landholder approval	Possible launch sites	Joins Murray River 100m downstream via a narrow permanent creek	High: deep pools, shallow outlet channel	<u>Moderate</u> : poor boat access during dry season, comparable habitats
Sue Smiths Nature Refuge (159852)	Requires landholder approval	Limited boat access	Limited connectivity with surrounding waterbodies	Low: minimal dry season aquatic habitat	<u>Low</u> : Minimal dry season aquatic habitat
Kyambul Lagoon (526453)	Requires approval from Cardwell Shire Council	Existing boat ramp	Kyambul Ck joins Murray R. 100-200m downstream of Kyambul lagoon via a permanent creek	High: shallow littoral and deep pools	<u>High</u> : Diverse and comparable habitat, good boat access
Warrami waterhole (Sherrin Ck)	Requires landholder approval	Possible launch sites	Sherrin Creek flows into Kyambul Ck via a permanently flowing creek	High: shallow littoral and pools	<u>Moderate</u> : Some difficulty launching boat during dry season
Ballera Ck (Sherrin Ck)	Requires landholder approval	Possible launch sites	Sherrin Creek flows into Kyambul Ck upstream of the lagoon	High: monotonous habitat - choked with instream vegetation	<u>Moderate</u> : Some difficulty launching boat during dry season
Un-named lagoon (Sherrin Ck)	Requires landholder approval	Possible launch sites	Sherrin Creek flows into Kyambul Ck upstream of the lagoon	Low: newly established artificial wetland	<u>Low</u> : although request from <b>CSC</b> to include in MTSRF project
Bunta Lagoon (509170)	Requires approval from Cardwell Shire Council	Existing boat ramp	Joins Murray river several km's downstream via permanent flowing creek	High: pools and shallow littoral	High: Diverse and comparable habitat, good boat access

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<b>Wetland name and size* (m2)</b>	<b>Vehicle access</b>	<b>Boat access</b>	<b>Connectivity with surrounding waterbodies</b>	<b>Habitat diversity</b>	<b>Suitability as study wetland</b>
Zamora's Lagoon (170962)	Requires landholder approval	Possible launch sites	Located adjacent to Murray River, connects intermittently via outlet channel	Low: pool habitat only	<u>Moderate</u> : Some difficulty launching boat
Lagoon Creek Lagoon (near Davidson Rd)	Requires landholder approval	Possible launch sites	Joins Tully River via small channel, permanent connection	High: pools and shallow littoral	<u>High</u> : Diverse and comparable habitat, good boat access
Selby's Lagoon (20529)	Requires landholder approval	Existing boat ramp	Joins Murray River via small channel, permanent connection	High: pools and shallow littoral	<u>High</u> : Diverse and comparable habitat, good boat access
Digmans Lagoon	Requires landholder approval	Possible launch sites	Connects to Murray River during overbank flows	High: pools and shallow littoral	<u>Moderate</u> : Some difficulty launching boat
Landcare Lagoon	Requires landholder approval	Possible launch sites	Connects to Murray River during overbank flows	Low: pool habitat only	<u>Moderate</u> : Some difficulty launching boat

\* Cardwell Shire Council (CSC)

**Trial of sampling methods**

Four sampling methods were trialled in five wetlands to (i) document the resident biota and (ii) assess their ability to measure attributes of the fish and invertebrate assemblages (Table 2, Appendix 1). Sampling effort was standardised during this exercise by (i) the area of habitat or (ii) the duration of sampling.

**Table 2:** Four sampling methods trialled in the Tully-Murray wetlands

<b>Group/taxon</b>	<b>Sampling method</b>	<b>Habitat sampled</b>	<b>Standardisation of sampling effort</b>	<b>Comments</b>
<b>Zooplankton</b>	Plankton trawl	Shallow and deep pools	<u>Area:</u> Number of individuals per m <sup>3</sup>	Plankton net dimensions = 0.5 x 1m; Mesh size = 63 and 250 µm; Tow duration = 5 minute tows
<b>Edge macro-invertebrates</b>	Dip net	Shallow littoral: pools	<u>Area:</u> Number of indiv. per area of microhabitat.	Dip net dimension = 0.5m <sup>2</sup>  Available microhabitats a) Leaf litter b) Root mass c) submerged/emergent vegetation d) Macrophyte
<b>Fish</b>	Plankton net	Shallow and deep pools	See zooplankton sampling design	
	Fyke net	Shallow littoral: pools and inlet channel	<u>Time:</u> Number of indiv. per hour of sampling time	Wing entrance 4m in width; set duration = 24 hours
	Electrofisher	Shallow littoral: pools	<u>Time:</u> Number of indiv. per e'fishing shot	Multiple 30 sec. e'fishing shots

## **Preliminary findings**

### **1. Zooplankton**

To be completed

### **2. Edge macroinvertebrates**

To be completed

### **3. Fish**

Seventeen species of fish from 11 families were recorded during the trial of three fish sampling methods (Appendix 1). Plankton trawls sampled different habitat than the fyke nets and electrofishing and effectively collected different size classes of some species. For example, larvae of *Redigobius bikolanus* and *Hypseleotris galii* were recorded plankton trawling but were represented as juveniles in the fyke nets and electrofishing catches. *Nematolosa erebi* were also recorded in the plankton trawls as larvae but were absent in the fyke nets and the electrofishing sample due most likely to their preference for deep pools as adults. This habitat was not sampled by the two latter methods.

*Ophisternon* sp. was recorded in the electrofishing sample but was absent from fyke net catches whereas *Denariusa bandata* was represented in the fyke nets but not in the electrofishing sample. These differences are possibly due to avoidance by the fish to the sampling method and/or their behaviour given that both methods were trialled in similar littoral habitat.

### **Further Investigation – Pilot study?**

The following wetlands would be the most accessible year-round by vehicle and boat outside of flood periods. They all have a diverse array of habitats that are comparable with one another that would allow the same sampling methods to be repeated among wetlands.

1. Barrett's
2. Boongaray
3. Kyambul
4. Bunta/Hassles
5. Selby's
6. Lagoon Creek lagoon (near Davidson Rd)
7. Artificial lagoon (Cardwell Shire Council request for inclusion in MTSRF study)
8. Boars (not yet inspected but reportedly good fish habitat. Source: CSC)