



**Australian Government**

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

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

**Project 3.7.1 – Marine and Estuarine indicators and thresholds of concern**

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**Summary**

All milestones are on track. Since the last report on the 15<sup>th</sup> January, a report on a comparative study developing biomarkers for exposure to estuarine pollutants in Barramundi has been completed. A manuscript proposing the use of light, together with chlorophyll, as integrative and ecologically relevant proxy measure for changes in water quality, and the effect of light limitation on reef development in the Whitsundays, has almost been completed. Last revisions of the Catchment-to-Reef Report have also been completed, and the 10 Chapters are about to be sent to a design company for final layout, before being uploaded onto the Catchment-to-Reef and MTSRF website. Two field trips to the Whitsundays (12 days at sea on a research vessel) resulted in valuable data backing the development of reef bioindicators. Work on the review of estuarine biomarkers and seagrass indicators is also progressing well.

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***For reference: Milestone extracted from Project Schedule***

***Report 2 submission***

- Progress update for activities listed against objectives a, b, d (above). [AIMS]
- Progress update for activities listed against objective c (above). [QDPI]
- Final report on use of stress markers in barramundi as indicators of water quality (obj d). [AIMS]
- Progress update on literature review on potentially useful ecological indicators of the condition of North Queensland's estuaries [JCU].
- Summary of any liaison activities undertaken to date. [AIMS]

## Project Results

### Description of the results achieved for this milestone

***a) Field testing and analysis of marine biofilms (bacteria, diatoms, foraminifera) for their suitability to indicate changes in water quality. [AIMS]***

On track. The biofilms research has mostly focused on foraminifera as probably the most effective and versatile group of biofilms biomarkers in the reporting period. Since January, a transplantation field experiment was completed, which involved 2 field trips to the Whitsunday for deployment and retrieval. The samples are now being processed. Additionally, foraminifera samples from all 30 inshore reefs monitored for the Reef Plan are being processed. These samples will provide further information on spatial patterns, complementing sampling done along the Whitsundays gradient and the study on temporal changes through the transplantation experiment. Once these samples are processed the resulting data will allow linking patterns in foram communities to patterns in coral communities. Two manuscripts on the role of foraminifera as indicators for water quality conditions are now in preparation.

***b) Field testing and analysis of coral reef organisms and physiological change tested for their suitability to indicate changes in water quality and ecosystem condition. [AIMS]***

On track. In the reporting period since January, the analyses of a large set of physiological samples has been completed, and results are now being statistically analysed. Furthermore, a manuscript proposing the use of light, together with chlorophyll, as integrative and ecologically relevant proxy measure for changes in water quality, and the effect of light limitation on reef development in the Whitsundays (20° 10' S, 148° 50' E), has almost been completed. This manuscript examines the spatial variation of water column characteristics, sediment and irradiance on coral reefs in the Whitsunday Islands region of the GBR, along a gradient from outer reefs distant from terrestrial inputs, to coastal reefs near the Australian mainland and the mouths of two rivers. Most of the water column variables (especially chlorophyll a, total suspended solids, total organic carbon and particulate nutrients) and all irradiance variables (Secchi and optical depth) changed significantly along this gradient. For example, concentrations of chlorophyll a and total suspended solids increased two- and three-fold, respectively, from offshore to coastal locations, while sediment inorganic carbon decreased and sediment colour became lighter. Similarly, the irradiance variables Secchi and optical depth, two measures of water transparency, decreased approximately three-fold towards the coast. The maximum depth of zooxanthellate corals to form reefs increased five-fold along the gradient and was related significantly to the optical depth of the water column. We highlight the usefulness of 'optical depth' as a proxy variable to quantify water column characteristics relevant for coral reefs, because (a) light is a key resource for photosynthetic reef organisms, (b) light changed consistently along the water quality gradient, and (c) is easily and inexpensively measured in-situ during field surveys or from satellite imagery. The relationship between water clarity and lower depth limit of reef development deserves further study; if changes in water clarity would indeed result in a change in the lower depth distribution in corals, the latter may be used as an indicator for changes in water column properties, similar to the use of the lower distribution limits of seagrasses in assessments of estuarine ecosystem health.

**c) Report on relationships between seagrass communities and sediment properties along the Queensland coast. [QDPI]**

Methods have been developed to convert the sediment properties data within the Seagrass-Watch data to a more "quantitative" measure apportioned by grain size. The conversion is based on the CRC Deepwater seagrass survey sediment data, where both deck descriptions and grain size analyses exist, allowing to back-relate the "deck description" type seagrass watch data to grain sizes. This approach was successful in many cases, and conversions will be finalised soon.

**d) Analysis of stress markers in estuarine barramundi in response to contrasting water quality in four estuaries. [AIMS]**

This Report has now been completed. For this study water, sediment and barramundi (*Lates calcarifer*) samples that were collected from five North Queensland estuaries along a perceived pollution gradient in 2002 were processed and analysed for trace organic contaminants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine and organophosphate insecticides and metals. As well, the pollution-induced responses of a suite of seven biochemical parameters (phase I biotransformation enzymes (eg. EROD, P450), fluorescent aromatic compounds (FACs), DNA damage, RNA:DNA ratio and neurotransmission enzymes) and two condition indices (condition factor and hepatosomatic index) were measured in barramundi. The resulting database was subjected to uni- and multi-variate analyses in order to determine the most suitable biomarkers to assess pollution in North Queensland estuaries and to classify the environmental quality of the sites. Principal components analysis (PCA) on the biochemical markers revealed that EROD, EROD/P450, DNA damage and to a lesser extent cholinesterase activity (ChE) and fluorescent aromatic compounds (FACs) were found to be responsive to contaminants in the environment while cytochrome P450, condition factor and the hepatosomatic index were found to be less responsive biomarkers. Of particular significance was the ability of the ChE assay to detect the presence of organophosphate insecticides, compounds that are notoriously difficult to detect in environmental samples analytically. Discriminant analysis (DA) was used to classify the pollution status of the various estuaries. It appears that the best discrimination between the various sites was obtained using DA on the biomarkers; however, further analysis using water quality parameters and levels of organic contaminants in water and sediment produced a similar pattern as found with the biomarkers. This was the first study to employ multiple biomarkers in a resident fish species in Queensland, and has demonstrated the utility of applying a multi-biomarker approach in conjunction with traditional analysis of contaminants in providing valuable information in environmental risk assessment.

**e) Literature review on potentially useful ecological indicators of the condition of North Queensland's estuaries [JCU, GU]**

On track. In total, 565 references were collected and reviewed, and a detailed outline of the review has been finished. A first draft of the Introduction is also completed, and work is progressing well.

**f) Develop data exchange agreements between organisations as basis for integrated report card development in collaboration with CSIRO, QDPI, GU, JCU. [AIMS]**

MTSRF and DEH jointly with the Research Providers, is in the process of developing a public access and data sharing agreement, which will fulfil the purpose that separate two-way agreements between the participants of this Project would have achieved.

**Communications, major activities or events**

**During milestone reporting period**

- The Reef team held a 2-days workshop with MTSRF Team 1.1.5 (Bill Venables, Glenn De'ath) to discuss statistical aspects of indicator development and decide on collaboration. Outcomes of this workshop will be reported through 1.1.5.
- The Reef team contributed to a Workshop to develop and decide on Reef Plan Marine Monitoring methods for the coming years (15th and 16th March).
- K. Fabricius participated in the Integrated Report Card Framework held in Brisbane on the 5th March.
- K. Fabricius met with GBRMPA, Reef Partnership and other MTSRF Projects to discuss the joint development of a Conceptual Model on land-sea interactions, and the effects of water quality on reef health.
- K. Fabricius participated in a meeting with GBRMPA to discuss scientific underpinning of the Water Quality Guidelines.
- K. Fabricius participated in a MTSRF WQ Operational Committee Meeting.

**During next milestone reporting period**

We will focus entirely on report writing. Forecast variations to planned milestones: K. Fabricius proposes to write the Milestone 'Conceptual Model for reef ecosystem condition in relation to changing river discharges' as a component within the WQ Synthesis report (with Jon Brodie as Senior author), and to also incorporate the Conceptual models presently developed by other organizations (Reef Partnership, GBRMPA). The advantage will be that several different approaches for conceptual models will be combined, becoming a core element of a high-profile synthesis report that will provide additional interpretation and background on the last 5 years of research outcomes to the models. This approach is considered to value-add to the synthesis report without losing information, hence more sensible than producing a separate report on the conceptual model, and both GBRMPA and Reef Partnership are strongly supporting this approach.

Objective	Targeted Activity	Date
a	Field testing and analysis of marine biofilms (bacteria, diatoms, foraminifera) for their suitability to indicate changes in water quality. [AIMS]	10 June 2007
b	Field testing and analysis of coral reef organisms and physiological change tested for their suitability to indicate changes in water quality and ecosystem condition. [AIMS]	10 June 2007
c	Report on relationships between seagrass communities and sediment properties along the Queensland coast. [QDPI]	10 June 2007
d	Analysis of stress markers in estuarine barramundi in response to contrasting water quality in four estuaries. [AIMS]	March 2006
b	Contribute to GBR workshop held on reef health indicators and thresholds of concern with program 1.1.2 [AIMS]	Dec 2006
b	Contribute to integration workshop to define end-user needs for reporting on issues related to freshwater water quality and ecosystem health. [AIMS]	
d	Literature review on potentially useful ecological indicators of the condition of North Queensland's estuaries [JCU, GU]	10 June 2007
b	Conceptual framework for reef ecosystem condition in relation to changing river discharges. [AIMS]	10 June 2007