Australian Government
Department of the Environment, Water, Heritage and the Arts

Marine and Tropical Sciences Research Facility Milestone Report, November 2008

Program 7: Halting and Reversing the Decline of Water Quality

Project 3.7.1: Marine and estuarine indicators and thresholds of concern

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Summary

All milestones are on track.

Biofilms: Experiments exposing foraminifera *in situ* and in aquaria to different water quality conditions are ongoing. Interim results remain promising. In September/October 2008, several further foraminiferal species (*Marginopora spp.*, *Peneroplis spp.*) were exposed in aquaria to different light, nutrient and temperature conditions. We are currently also testing to see if organic carbon and nitrogen content of foraminifera reflects local water quality conditions. In addition, two new PhD students have commenced work in the Biofilm project. One student (J. van Dam) is investigating the interactive effects of global change (temperature) and pesticide exposure on foraminifera. The second student (V. Witt) will continue our studies on changes in the bacterial community due to water quality. Two field trips to the Whitsundays were also completed for deployment and retrieval of potential indicator species along water quality gradients.

Corals: To test the validity across regions of previously proposed indicators, coral indicators (physiological and community based) were collected from three reefs each of four inshore regions of the GBR between Rockhampton and Port Douglas. These samples are now being processed in the laboratory.

Estuaries: Work to develop tools for evaluation of estuarine ecosystem condition is progressing well. Apart from interruptions due to adverse weather, data for the main study have been collected every month from November 2007, with data up to September 2008 already analysed. Preliminary analyses from data from nine estuaries are summarised in a separate report. In brief, the data suggest that summary measures (e.g. total abundance, species richness) show little relationship to impact status, except where health is extremely degraded. They also show that variation in assemblage structures between estuaries is not predictable in terms of proximity (neighbouring estuaries can not be used as reference sites), but within estuaries, communities are consistent over time once season is factored in. This suggests that changes over time within estuaries may be best to establish deviation from reference conditions. However, seasonality has to be factored in, with reference conditions needing to refer to particular points in time as well as to a specific estuary. This aspect will be further investigated with the data currently being collected. The surprising temporal consistency also indicates that there is great potential in developing the use of process-specific variables as measures of estuary condition. Successful scavenging pressure studies

indicate it has considerable potential as a measure of ecosystem condition, particularly when combined with other estuary specific approaches. Remaining field and laboratory work is well in hand, with most laboratory components finishing at, or shortly after, completion of field sampling.

Project Outputs / Milestones

Objective	Targeted Activity	Due Date
(a)	Field testing and analysis of marine biofilms (bacteria, diatoms, foraminifera) for their suitability to indicate changes in water quality. [AIMS]	June 2009
(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]	June 2009
(c)	Contribution to research on seagrass communities and their responses to changing environmental conditions along the Queensland coast. [QDPI&F]	June 2009
(d)	Conduct research towards identifying potentially useful ecological indicators of the condition of North Queensland's estuaries. [JCU, GU]	June 2009

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: Biofilm research has mostly focused on foraminifera as probably the most effective and versatile group of biofilms biomarkers in the reporting period. In total, three large-scale transplantation field experiments have now been completed, each involving two field trips to the Whitsundays for deployment and retrieval. Analysis of growth data from two species clearly shows that the two species tested grow faster in water further removed from the mainland, and thus potentially from nutrient sources. However, initial experiments including nutrient addition seem to indicate that nutrients are not the main cause for the reduced growth. Foraminifera samples from all thirty inshore reefs monitored for the *Reef Plan* are being processed and statistically analysed, and preparation of a manuscript comparing these to coral community data is well under way. Initial analysis of carbon and nitrogen from foraminifera indicated that the nitrogen content in these might be an indicator for water quality conditions on the respective reefs. Further data are being analysed. The first dose repose curves for the effect of diuron on several foraminiferal species have been produced.

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: We have completed field trips (18-day and 8-day lengths) to collect coral indicator samples from three reefs along water quality gradients each within four of the *Reef Plan* monitoring regions (Figure 1): The Keppels (Barren Island, Humpy Island, Pelican Island); the Whitsundays (Pine Island, Daydream/West Molle Island, Double Cone Island; the Burdekin (Geoffrey Bay, Pandora Reef, Pelorus / Orpheus Island); and the Wet Tropics (Dunk Island, High Island (Franklands) and Fitzroy Island).

The trips were conducted as a collaboration with the *Reef Plan* Monitoring Team (water quality and inshore monitoring teams), and James Cook University student, Helene LeGrand. Physiological and community indicators were sampled at two depths at each reef. Field indicator data included coral pigmentation, macro-bioeroder densities, surface complexity, partial mortality, and coral and octocoral juvenile densities and species richness. Laboratory samples are currently being processed for skeletal density, RNA/DNA ratio, protein and pigmentation.

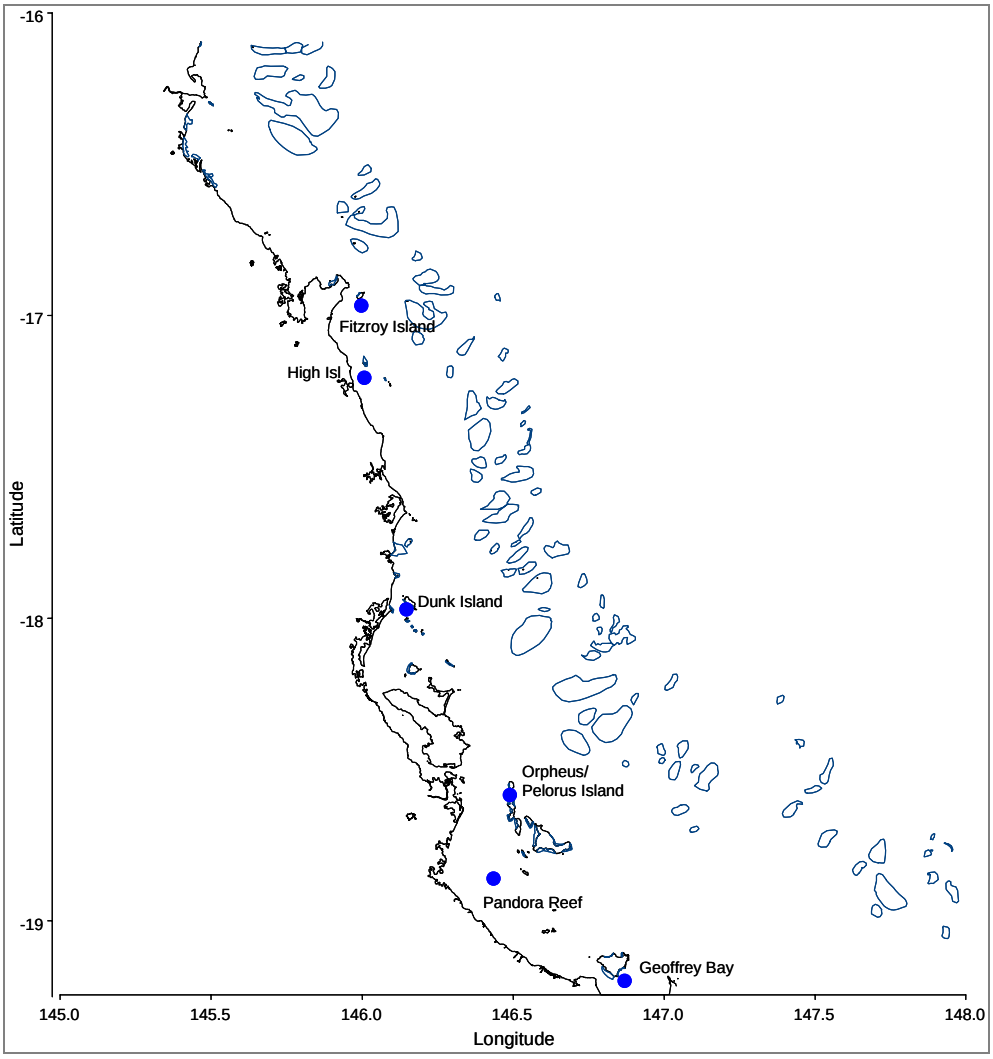

Figure 1: Study sites from four regions. Coral indicators were collected from two depths at each reef. **Note**, Figure 1 continued on page 4 of this report.

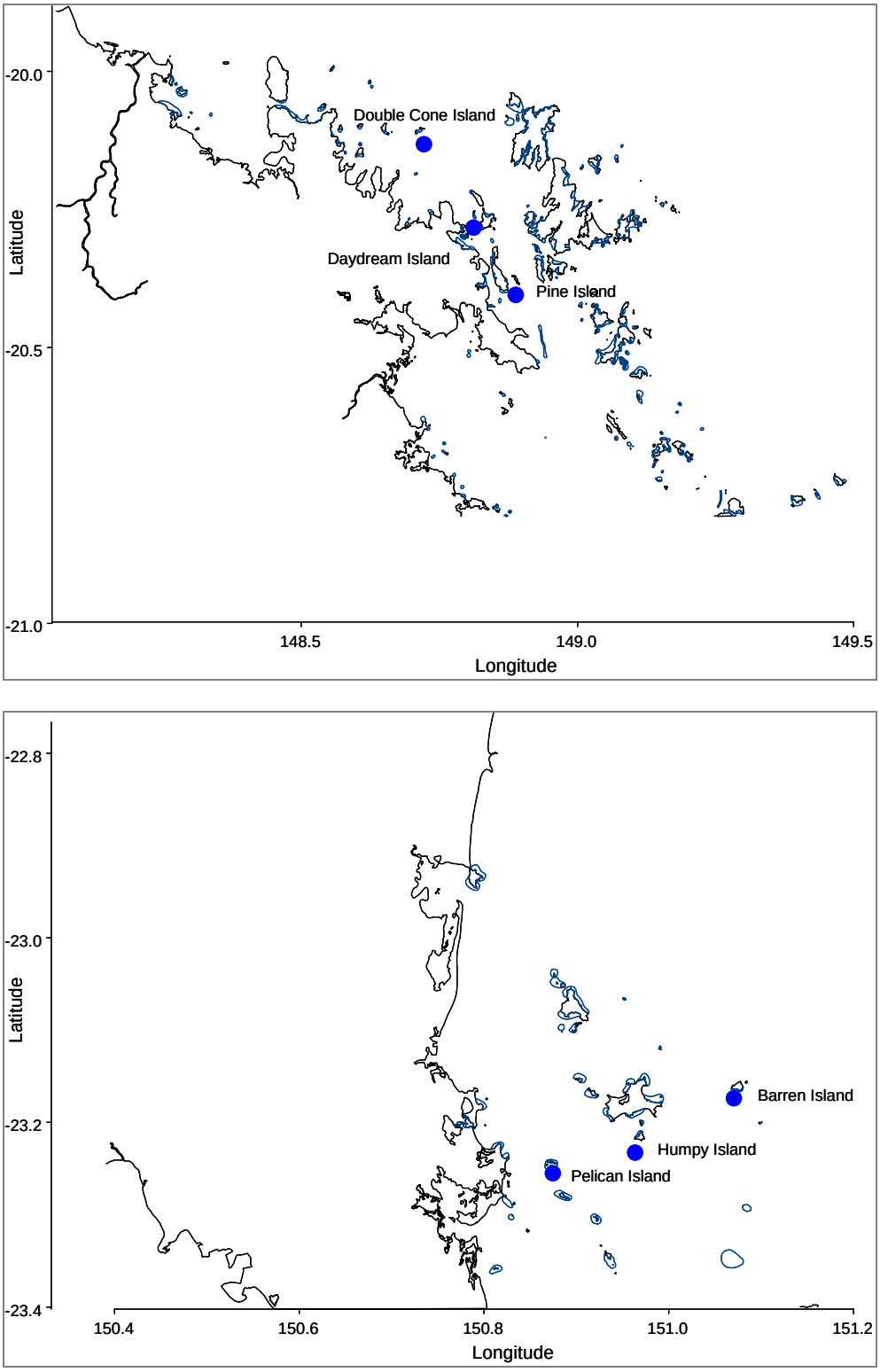

Figure 1 (continued): Study sites from four regions. Coral indicators were collected from two depths at each reef.

d. Ecological indicators of the condition of North Queensland's estuaries. [JCU, GU]

On track.

Communications, major activities or events during milestone reporting period

- K. Fabricius contributed to the Scientific Consensus Statement on the Effects of Water Quality, and attended the *ReeFocus* Summit, Brisbane, 24 October 2008.
- S. Uthicke presented results of the foraminiferan research at the International Coral Reef Conference, Florida (see Appendix 1 to this report for Abstract).
- Completion of two publications:
  - Nobes, K., S. Uthicke, and R. Henderson (2008) Is light the limiting factor for the distribution of benthic symbiont bearing foraminifera on the Great Barrier Reef? *Journal of Experimental Marine Biology and Ecology* 363: 48-57.
  - Nobes, K. and S. Uthicke (2008) *Benthic foraminifera of the Great Barrier Reef. A guide to species potentially useful as Water Quality Indicators.* Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (44pp.) (http://www.rrrc.org.au/publications/downloads/371-AIMS-Nobes-et-al-2008-Benthic-Foraminifera-of-the-GBR.pdf).

Appendix 1

Abstract presented by S. Uthicke (AIMS) at the International Coral Reef Conference, Florida, 2008:

WATER QUALITY IN NEARSHORE AREAS OF THE GREAT BARRIER REEF: A LARGE SCALE MONITORING PROGRAM AND AN ASSESSMENT OF THE USE OF BENTHIC FOARMINIFERA AS WATER QUALITY INDICATORS

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As for most Coral Reefs, a potential decline in water quality (WQ) is a concern for reef health of Great Barrier Reef (GBR) inshore reefs. A large scale (32 reefs, 4 regions) GBR inshore monitoring program was initiated in 2005, encompassing annual coral community analysis, and half-yearly WQ measurements. We additionally investigated the benthic foraminifera at these monitoring sites to evaluate their utility as WQ indicators in the GBR. WQ measurements confirmed that most parameters (e.g. chlorophyll *a*, suspended solids) are higher in inshore areas of the GBR when compared to offshore reefs. Higher concentrations of most parameters were measured during the wet season, but regional differences in WQ were more distinct in the dry season.

Regional differences in coral cover and community composition are pronounced. A substantial proportion of the variation in coral community composition is explained by differences in the hydrodynamic conditions, with several genera resilient to sedimentation attaining consistently higher relative abundance in areas where fine sediments predominate. Coral cover estimates mostly reflect recent disturbance history rather than WQ conditions. Along a distinct WQ gradient, the FORAM index (FI), as previously developed and applied in the Caribbean, showed a high correlation with WQ. Foraminiferan communities also showed distinct regional differences. While the FI did not predict coral cover, one symbiont-bearing species (*Calcarina mayori*) was positively correlated with high algal/low coral cover. Because of the vulnerability of corals to other disturbances it appears that foraminifera are more specific indicators for WQ. Combined analysis of the WQ, coral- and foraminiferan community data from this monitoring program provides important insights into the value of WQ indicators based on individual species' density or a combined FORAM index. We consider the future application of this index in the GBR as beneficial, after refinements in the weighting of individual species.