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

Project 1.1.3 – Condition, trend and risk in coastal habitats: Seagrass indicators, distribution and thresholds of potential concern.

Project Leader: **Associate Professor Michelle Waycott, JCU and Len McKenzie, QDPI&F.**

Institution: **James Cook University (objectives b and c) and Queensland Department of Primary Industries and Fisheries (QDPI&F) (objectives a and c)**

Summary

Objective a

The project has conducted detailed studies of inter-tidal seagrass meadows on the east coast of Queensland as part of the Reef Plan Marine Monitoring Program. Intertidal seagrass cover and abundance in 2008 was generally higher than compared to monitoring periods in previous years. Some localised changes have occurred, but there is no overall trend. Declines at some sites appear primarily due to natural physical disturbance (sediment movement). Locations which were reported to decline in 2006, have continued to recover indicating overall seagrass communities appear to have been resilient to changes at the GBR scale. The Seagrass-Watch monitoring has been successfully undertaken and updates are available on www.seagrasswatch.org.

Objective b

Experimental work to evaluate thresholds of seagrass survival have established that repeated episodes of high water temperature spikes to 40°C are likely to have a considerable impact on seagrass meadow health and on their ability to tolerate other impacts. Short-term exposure to temperatures at 43 degrees are lethal and are beyond the capacity for the seagrass plants to adapt, even for one day. These results can guide our interpretation of seagrass responses to temperature in field investigations. We observed an interaction between light and water temperature which requires further targeted investigation. This will be carried out in 2009.

Long term exposure to elevated temperatures indicate a switch to reduced biomass at warm water temperatures. This is likely to be a consequence of higher respiration rates at warmer water temperatures. These experiments were carried out under controlled light conditions. In natural conditions, increases in water temperature associated with seasonal cycles are usually accompanied by increases in light intensity (solar irradiance) up to the solstice in December. Therefore, if the seagrass plants are able to maintain or even increase their photosynthetic efficiency in warmer water when light intensity is also higher.

As a result plants would be capable of higher rates of photosynthesis compared to winter periods, and thus compensate for increases in respiration.

The next important phase of this work will be to investigate the interactive role of light and water temperature on these seagrass species. This will be carried out in 2009. Environmental monitoring sites have been established and data collection is ongoing.

Objective c

A workshop to assess the present risk to coastal seagrass communities from anthropogenic activities in the Burdekin Dry Tropics and Wet Tropics NRM regions was held in May, 2008. A Delphic approach was used at the workshop to: (1) identify the various hazards to inshore seagrass communities of the dry and wet tropics; (2) identify the spatial (GIS) datasets that delineate these hazards; and (3) rank and weight the relative risk to inshore seagrass communities from each of the identified hazards. The information provided by experts was used to quantify the relative risk to coastal seagrass communities in the Dry and Wet Tropics via a spatial risk assessment approach.

The project is now reviewing the approach used to test applicability to a wider geographic spread. It is also assessing other parameters for assessing the concept of risk that were not included in the previous workshop but that we feel could inform our understanding of how coastal systems respond. We have tested our ideas at an international conference and workshop.

For reference: Milestone extracted from Project Schedule

Report 1 submission QDPI&F (with appropriate attribution of MTSRF Funding):

- Report on Seagrass-Watch intertidal: locations, abundance, community structure and distribution at agreed sites (newsletter) (obj a)

- Plan of any communication products/events for Year 2 and summary of any communication activities undertaken to date, including minutes of meetings/workshops as applicable (obj a)

Report 1 submission JCU (with appropriate attribution of MTSRF Funding):

- Experimental results from initial mesocosm experiments (b2)

- Summary of data outputs from light loggers at field sites (b3)

- Evaluation of the effectiveness of the risk assessment case study and its applicability to a wider range of locations (c1)

- Plan of any communication products/events for Year 2 and summary of any communication activities undertaken to date, including minutes of meetings/workshops as applicable (b) and (c)

- Pathway to Impact Report for end user relevance.

Project Results

Description of the results achieved for this milestone

QDPI&F achievements (relevant objective in parenthesis)

- All milestone activities have been successfully achieved.
- Seagrass-Watch monitoring for intertidal seagrass abundance, community structure, and physical parameters was conducted at intertidal Seagrass-Watch and several Reef Plan MMP sites in Queensland in July/August 08 (a).
- A Seagrass–Watch newsletter (issue 34) was produced and distributed in September 2008 updating participants on program developments and results of ongoing monitoring (see http://www.rrrc.org.au/publications/seagrass_watch_newsletters.html or http://www.seagrasswatch.org/newsletters.html). Issue 35 is currently in development and will be available in mid December 2008 (a3).
- The Dry Season monitoring of seagrass abundance, community structure and distribution was conducted at all 30 intertidal Seagrass-Watch/Reef Plan MMP sites in September/October 08. All sampling was successfully completed (see http://www.seagrasswatch.org/sampling.html) (a1).
- Light loggers were deployed at selected intertidal coastal and reef seagrass field sites in the Townsville and Cairns regions (b3). Loggers in the Townsville region have been deployed with automated.
- Regular (1-2 per month) E-bulletins are distributed electronically to Seagrass-Watch participants and related international forums/discussion groups on seagrass related news events and Seagrass-Watch activities.
- A draft final report for Reef Rescue MMP - intertidal seagrass has been submitted to MTSRF.
- Len McKenzie and Jane Mellors attended the 8th International Seagrass Biology Workshop (Bamfield, Canada, 31 August – 6 September 2008) and presented on the Reef Plan Marine Monitoring Program and Seagrass-Watch.

JCU achievements (Objective b)

- Experiments on the role of changes in water temperature on tropical seagrass species has been undertaken in control environment facilities. There were two components to this work: the first was an investigation into the influence that short-term spikes in water temperature (simulating low tide) have on tropical seagrass species (Attachment B) and the second was on the impacts of long-term temperature changes on seagrass (Attachment C).
- In the temperature spike experiments, water temperature was increased for 2.5 hrs each day to simulated changes in water temperature that occur in intertidal meadows at low tide. The water temperatures were 35, 40 and 43°C, which is the range in temperatures that have been observed during our field monitoring (Attachment A). The seagrasses survived the increases in water temperature for a full 6 days in the 35 degree and 40 degree temperatures, but at 43 degrees, all seagrasses were dead after 3 days. The short-term changes in water temperature had an effect on photosynthesis, with some positive effects at 35 degrees, a slightly negative effect at 40 degrees and a large impact at 43 degrees.

- In the long-term temperature manipulation experiment, we aimed to determine the effect that long-term changes in water temperature have on the growth, morphology, physiology and sexual reproduction in a number of tropical seagrass species. The work timed to coincide with flowering, or the lead up to it. A number of characteristics of the seagrasses were measured throughout the experimental period, including growth, morphology and physiology. Some of these analyses are still to be completed. Growth was higher in water temperature of 27°C and 30°C compared to ambient water temperature (~23°C). Despite these higher leaf growth rates, shoot density was unaffected in *C. rotundata* and was lower in *H. uninervis* and *T.hemprichii* compared to ambient water temperature. Morphological characteristics, including leaf length, leaves per shoot and leaf width, were also unaffected or reduced (except for a small increase in leaf width in *C. rotundata*) in the water temperature treatments.
- Field monitoring sites have been set up at Picnic Bay, Dunk Island, Green Island and Low Isles. The Picnic Bay site was set-up as a trial monitoring sites, and the set up of the remaining sites has continued throughout the year (Attachment A).
- Some environmental data is available for the Picnic Bay site. Light intensity is considerably greater at the intertidal site compared to the subtidal site. The greatest difference between total daily light availability was from June to September when light was 4.4 – 6.6 times greater at the intertidal site than the subtidal site, while in the remainder of the year, light was 1.2 – 3 times greater at the intertidal site. Temperature extremes are also considerably greater in the intertidal meadows compared to the subtidal meadows. It is too early in the data collection phase to draw any conclusions about the role that changes in temperature and light have on seagrasses at any one site, however, we can see some general differences between sites. Monitoring of the field sites will be ongoing until the completion of project 1.1.3.

QDPI&F and JCU achievements (Objective c)

In reviewing our model we have taken four approaches:

1. Reviewing some aspects of our data to ensure integrity

Some spatial layers used in the report “Spatial Risk Assessment for Coastal Seagrass Habitats in the GBRWHA A case study of the Dry and Wet Tropics” were not intuitive and we have checked source data. Checks have confirmed the accuracy of the report.

2. **Presenting the approach at an international workshop and seeking feedback**
The project leaders participated in a workshop session as part of the International Seagrass Biology Workshop 8 in Canada and the results are being compiled for comparative purposes.

3. Reviewing international literature on risk to ecosystems
Recent papers on risk to ecosystems such as Halpern et al 2008 have suggested a slightly different approach to scaling and included factors not included in our report. We are working to include these ideas.

4. Developing a survey approach to add to the information provided in the May 2008 workshop
We are now starting the process of expanding our risk assessment to the entire GBR coast as required by the contract. We have developed a survey for the May workshop participants. This survey will ask experts to report on extra factors such as frequency of impact and resilience (recovery time) to improve our underlying risk model.

Summary outputs from the current model are attached in appendices c1-c3.

Problems and opportunities

Objective c

We are investigating better ways to engage the international community and are considering contacting key workers in this field for advice and data.

Communications, major activities or events

During milestone reporting period

Reports
McKenzie, L.J., Mellors, J.E. and Waycott, M. (2008). Great Barrier Reef Water Quality Protection Plan (Reef Rescue) – Marine Monitoring Program, Intertidal Seagrass for the Sampling Period 1st September 2007 – 31st May 2008. 127pp.
Grech, A., Coles, R., McKenzie, L., and Rasheed, M. (2008) *Spatial risk assessment for coastal seagrass habitats in the GBRWHA: A case study of the dry and wet tropics.* Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (18pp).

Newsletters
(http://www.seagrasswatch.org/newsletters.html)
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch News – issue 34, September 2008. 12pp.

Brochures
(http://www.seagrasswatch.org/publications.html#Brochures)
McKenzie, LJ & Yoshida, RL (2008). Seagrasses of Dunk Island, 6pp.

Posters
Collier, C (2008). Seagrass research at Dunk Island.

E-bulletins
(http://www.seagrasswatch.org/publications.html#Ebulletin)
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 30 November 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 17 November 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 31 October 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 22 October 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 19 September 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 28 August 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 14 August 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 30 July 2008
McKenzie, LJ & Yoshida, RL (2008). Seagrass-Watch E-Bulletin, 07 July 2008

Conference Proceedings
McKenzie, L., Mellors, J., Waycott, M., Yoshida, R. and Smith, N. (2008) Intertidal seagrass condition, Seagrass-Watch and the Great Barrier Reef Marine Monitoring Program: developing indices of water quality. In. G. Di Carlo, A. Calladine, M. Waycott and T. Carruthers (Eds) Proceedings of the 8th International Seagrass Biology Workshop, Bamfield, Canada, 31 August – 6 September 2008. World Seagrass Association, Townsville, Australia. p48.

Mellors, J., McKenzie, L., Waycott, M., Reid, A., Smith, N. and Yoshida, R. (2008). Monitoring of inter-tidal seagrass meadows for the GBR Water Quality Protection Plan (ReefPlan). In. G. Di Carlo, A. Calladine, M. Waycott and T. Carruthers (Eds) Proceedings of the 8th International Seagrass Biology Workshop, Bamfield, Canada, 31 August – 6 September 2008. World Seagrass Association, Townsville, Australia. p50.

Grech A., and Coles R (2008). A Predictive Seagrass Habitat Model for Eco-system Scale Marine Planning in the GBRWHA. Presentation to the 8th International Seagrass Biology Workshop Canada, 2008. In. G. Di Carlo, A. Calladine, M. Waycott and T. Carruthers (Eds) Proceedings of the 8th International Seagrass Biology Workshop, Bamfield, Canada, 31 August – 6 September 2008. World Seagrass Association, Townsville, Australia.

G. Di Carlo, A. Calladine, M. Waycott and T. Carruthers (Eds) Proceedings of the 8th International Seagrass Biology Workshop, Bamfield, Canada, 31 August – 6 September 2008. World Seagrass Association, Townsville, Australia.

Seminars and presentations

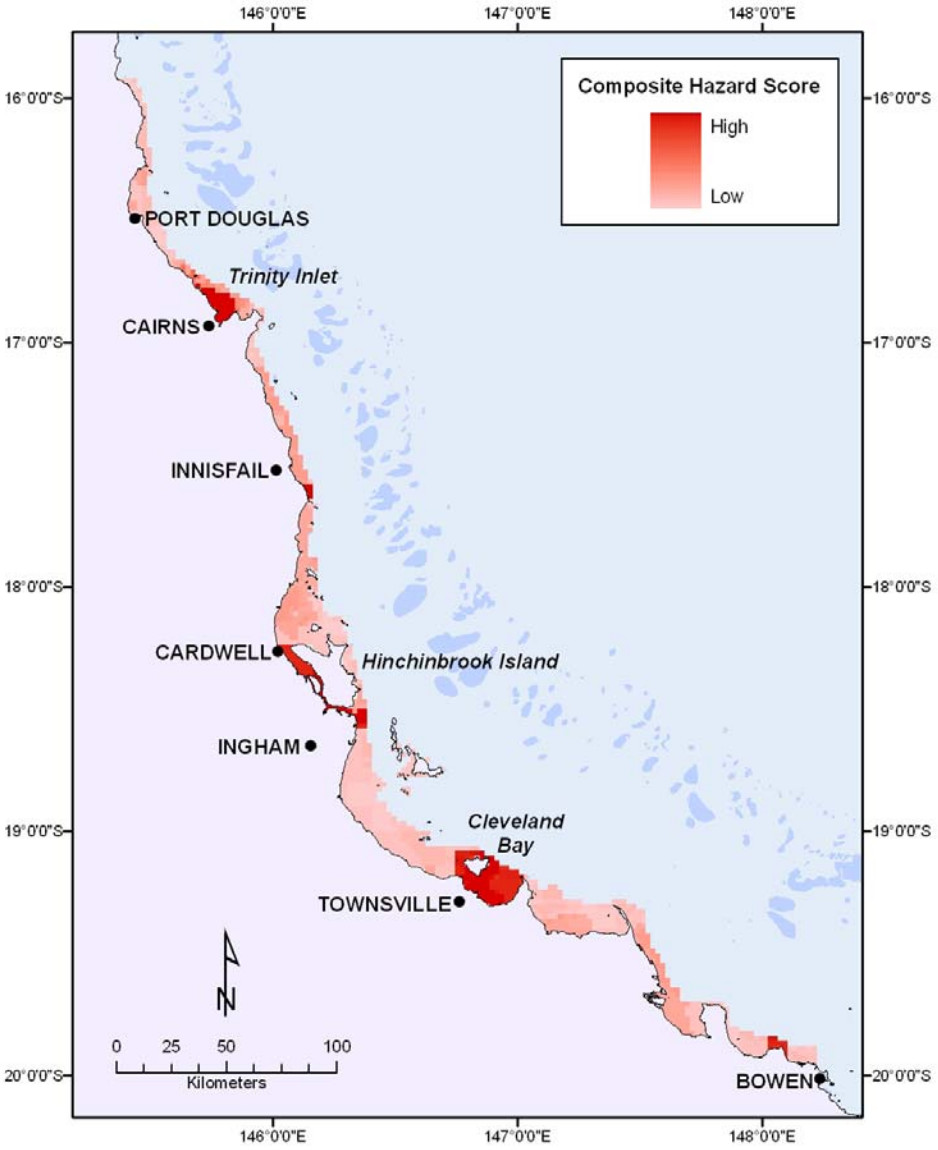
Mellors, J (2008). Seagrass-Watch Field techniques. Belgian Gardens Primary School - July 30.
Mellors, J (2008). How to Seagrass-Watch. Townsville Grammar School - Oct 10.
Mellors, J (2008). Seagrasses and Seagrass-Watch. International Youth Conference assisted with Belgian Gardens - Oct 20.
Mellors, J (2008). Field techniques for monitoring intertidal seagrass meadows Townsville Grammar School - Oct 23.
Grech, A., and Coles, R. (2008) Can global assessments of human impact on marine ecosystems inform local management initiatives? Presented at the School of Earth and Environmental Sciences Research Student Conference, Townsville November 13th.
Coles R. (2008) Seagrass management – Expert Knowledge – Priorities/Credibility/Scale; and introduction to the concept of risk.

During next milestone reporting period

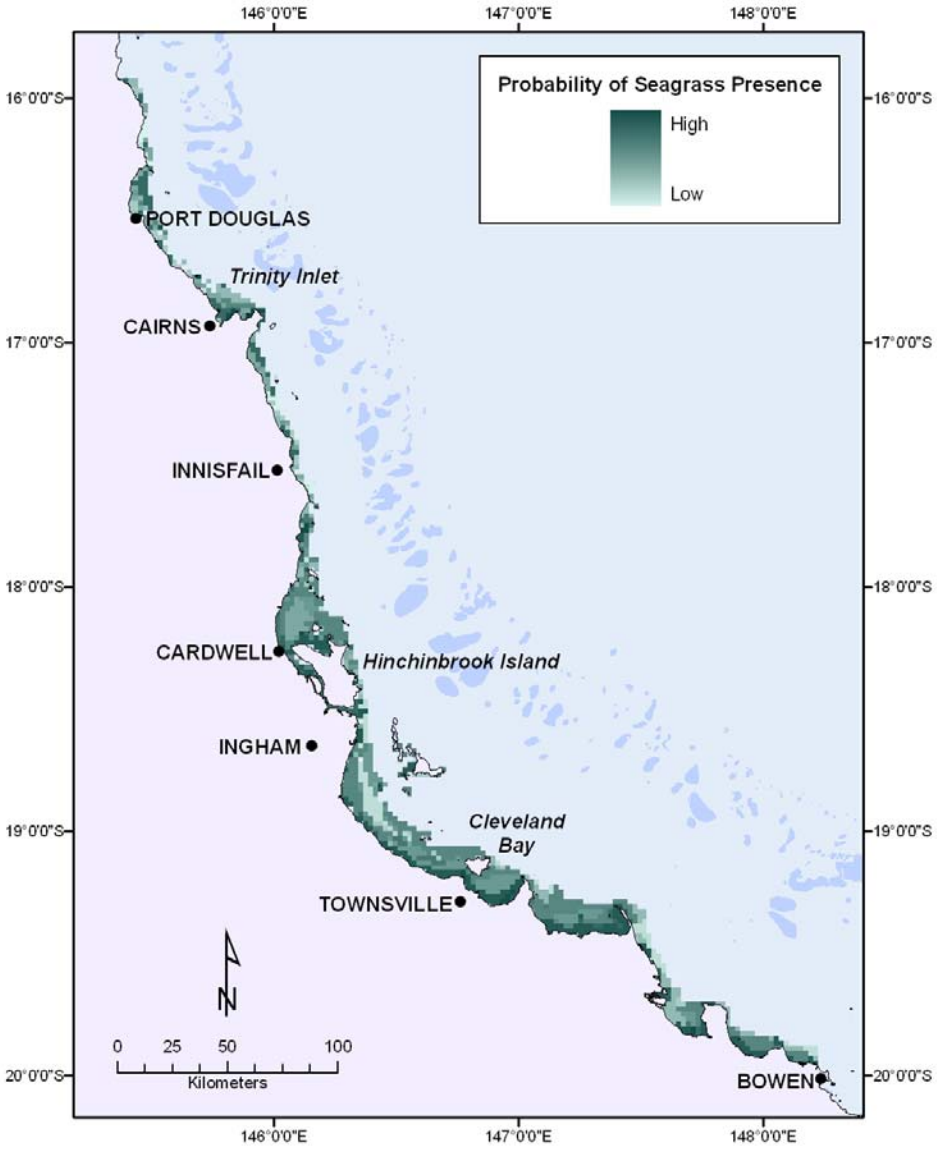
Seagrass–Watch newsletter issue 35 – December 2008
Seagrass–Watch newsletter issue 36 – March 2009
Seagrass–Watch newsletter issue 37 – June 2009
Publication for scientific journal on trawl risk to bottom habitats.
Publication (two papers) for scientific journal on temperature responses of seagrasses.
Publication on survival of seagrasses, mangroves and coastal tidal flats under climate change scencarios.
Full project team meeting in early 2009.

Appendices

Appendix c1: Composite hazard score for the coastal (<15m) region of the Dry and Wet Tropics derived from spatial information on the presence/absence of hazards and the relative hazard scores developed by experts.



Appendix c2: Probability model of coastal (<15m) seagrass presence in the Dry and Wet Tropics developed by Grech and Coles.



Appendix c3: Risk/consequence matrix for the coastal (<15m) region of the Dry and Wet Tropics. A risk/consequence grid that has a high score will have both a high composite hazard score and a high probability of seagrass presence; a grid that receives a low score can have a high composite hazard score and a low probability of seagrass presence or a low composite hazard score and a high probability of seagrass presence.