Water Quality and Ecosystem Monitoring Programme
Reef Water Quality Protection Plan

Final Report 2007/08

Britta Schaffelke, Angus Thompson, John Carleton, Edward Cripps, Johnston Davidson, Jason Doyle, Miles Furnas, Kevin Gunn, Stephen Neale, Michele Skuza, Sven Uthicke, Margaret Wright, Irena Zagorskis

Australian Government | Australian Institute of Marine Science

Townsville
August 2008

Acronyms

AIMS	Australian Institute of Marine Science
COTS	Crown-of-thorns starfish
RRRC	Reef and Rainforest Research Centre
GBRMPA	Great Barrier Reef Marine Park Authority
LAT	Lowest Astronomical Tide
LTMP	Long-term Monitoring Program
MTSRF	Marine and Tropical Research Facility
NRM	Natural Resource Management
QA/QC	Quality Assurance and Quality Control
QPWS	Queensland Parks and Wildlife Services
Reef Plan MMP	Reef Water Quality Protection Plan Marine Monitoring Program
Reef Plan	Reef Water Quality Protection Plan
WQIP	Water Quality Improvement Plan

local disturbance regimes, in order to improve our understanding of the processes shaping and or limiting inshore coral reef communities.

The assessment of benthic foraminifera assemblages was for the first time formally included in Reef Plan MMP to test their suitability as a bioindicator for water quality on a large spatial scale. The assemblage composition showed distinct regional patterns which reflected environmental conditions, and were, at least to some extent, related to water and sediment quality. Although slight changes in the community structure may have occurred over the last two year, our analysis showed that, overall, communities are stable, indicating relative stability of water quality conditions, as was suggested by the lagoon water quality sampling.

The high-frequent chlorophyll and turbidity data from autonomous instruments will be essential in the future of the Reef Plan MMP, as they will serve as correlative environmental variables for analysis of spatial differences in coral reef community structure. Together with remote sensing data, the instrument data should enable the detection of long-term temporal trends in coastal water quality because of their high resolution of short-term variability that in the past has obscured long-term patterns in programs using low-frequent manual sampling techniques.

in coastal waters between Cape Tribulation and Cairns from 1989 to the present. Sampling of these stations has been continued under Reef Plan MMP.

Surface chlorophyll concentrations in Great Barrier Reef waters have been measured since 1992 as part of a long-term monitoring program. The Reef Plan monitoring has been modified in 2006-07 to accommodate a change of sampling organisations from QPWS to tourism operators. Most sampling locations have been continued in 2007-08, but with varying degree of frequency, reliability and quality.

The coral monitoring program continued to survey the cover of benthic organisms, the numbers of genera and the number of juvenile sized coral colonies at 24 inshore reef locations in four NRM regions, the Wet Tropics, Burdekin, Mackay Whitsunday and Fitzroy regions. The coral recruitment monitoring was extended to now cover these four NRM regions.

This report provides details about the monitoring activities undertaken by AIMS as part of the Reef Plan MMP from May 2007 to April 2008.

We compared the seasonal average values for each sampling location which trigger values set in the GBRMPA Draft Water Quality Guideline for the Great Barrier Reef Marine Park (GBRMPA 2008). Levels for PN were rarely exceeded (two locations where the dry season value was just exceeded, and Pelican Island, the location closest to the Fitzroy River mouth, which was sampled twice during and after the Fitzroy flood; Table 2.4). The dry season trigger value for PP was exceeded at Dunk Island, and wet season values were exceeded by all wet season samples from the Fitzroy region and at Pine Island, the location closest to the Pioneer River mouth in the Mackay Whitsunday Region (Table 2.5). Chlorophyll dry season trigger values were exceeded at six out of 14 locations, one or two in each region, while wet season values were exceeded at two Mackay Whitsunday and all Fitzroy Region locations (Table 2.6). A closer inspection of chlorophyll trigger value exceedances is presented in the section about automated water quality loggers (below). While Secchi depth trigger values are often not met (Secchi depth values that do not meet the Guideline are lower than the trigger value, due to the nature of the parameter). Suspended solids trigger levels were only exceeded at Pine Island (Fitzroy Region) during and after the Fitzroy flood (Table 2.7).

Concentrations of most water quality parameters varied between the three sampling years within each of the four regions and for overall GBR averages. A summary of total GBR averages for the Reef Plan MMP inshore sampling locations over three years and comparative data are presented in Table 2.8. Mean values over the three samplings years of chlorophyll, suspended solids and Secchi depth were higher (lower for Secchi depth) than comparative long-term, large-scale GBR coastal zone values. Seasonal and annual means of these parameters and wet season and annual means of particulate phosphorus also exceeded the GBRMPA Draft Water Quality Guideline values (GBRMPA 2008). Only particulate nitrogen was lower than the comparative values as well as below the Guideline value.

Water column profiles of salinity, temperature and turbidity (as optical backscatter) were obtained at all sampling stations as additional information about the actual physical conditions during sampling, to aid interpretation of the measured values in the discrete-depth water samples (e.g., re-suspension due to strong winds, surface flood waters). Representative profiles for a pair of stations per region and season, representing different settings or conditions (generally one close to the nearest river mouth or coast, one further away from the coast), are shown in Figures A1-2.1 to AI-2.4 (Appendix 1). All dry season depth-profiles show a generally well-mixed water column, with the exception of chlorophyll fluorescence which slightly increases with depth. An exception is Double Cone Island in the Mackay Whitsunday NRM Region, which shows a thermocline in both seasons. In the wet season, the Wet Tropics stations show reduced surface salinity values (sampling occurred about 2 weeks after the last flood peak of the Wet Tropics rivers) and chlorophyll and turbidity readings that increased with depth (Figure A1-2.1). Wet season profiles in the Burdekin region were well-mixed with slightly reduced salinity and low turbidity (sampling occurred about 4 weeks after the last flood peak of the Burdekin River), while chlorophyll fluorescence increased with depth (Figure A1-2.2). The same applies to the wet season profiles of the two Mackay Whitsunday stations even though these were samples at the second major flood peak of the Pioneer River; the chlorophyll fluorescence was variable throughout the profiles (Figure A1-2.3). The two stations in the Fitzroy Region showed the clearest flood signature, they were sampled during the second major flood peak of the Fitzroy River. Surface salinity was much reduced (to 18 PSU at Pelican Island, 33 PSU at Barron Island), surface turbidity is very high at Pelican Island (which was inundated by the flood plume) and chlorophyll values are high and variable throughout the profile (Figure A1-2.4).

relatively similar turbidity values. Details of the time series from each of the 14 deployment locations are described in detail in the following section.

Five reef locations in the Wet Tropics NRM Region had instruments deployed.
Snapper Island, the northernmost location of the Reef Plan MMP inshore water quality network, had an extremely spiky record, especially for turbidity (Figure 2.10). The overall mean chlorophyll concentration was 0.51 µg L^{-1}, which was above the GBRMPA Guideline value. Mean turbidity was ~2 NTU, but frequent spikes were above this mean with a highest daily value of 18 NTU. 23% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values (Table 2.13) and 10% of values exceeded the suggested 5 NTU limit for coral photo-physiological stress. A 10 d period of high turbidity readings during March 2008 coincided with a flood event of the Daintree River; high chlorophyll values follow the turbidity readings with a lag of a few days.

The mean chlorophyll concentration at Fitzroy Island was 0.42 µg L^{-1} (Table 2.13). Mean turbidity was ~0.9 NTU, with two spikes in February reaching a maximum value of 8 NTU and elevated turbidity during the March flood of the Russell-Mulgrave River (Figure 2.10). 21% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and only 1% of values exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

Russell Island, in the Frankland Islands Group had the lowest chlorophyll and turbidity levels in the Wet Tropics Region (Figure 2.11). The mean chlorophyll concentration was 0.28 µg L^{-1} (Table 2.13). Mean turbidity was ~0.5 NTU, with elevated turbidity during the March flood of the Johnstone River but a maximum value of only ~2 NTU (Figure 2.10). Only 3% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and none exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

High Island had a mean chlorophyll concentration of 0.37 µg L^{-1} and a mean turbidity of 0.9 NTU (Table 2.13). Maximum turbidity was ~7 NTU, reached during a period of elevated turbidity during the March flood of the Johnstone River (Figure 2.11). 12% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and only 1% exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

Dunk Island chlorophyll and turbidity levels and variability over time were comparable to Snapper Island. Dunk Island had a mean chlorophyll concentration of 0.48 µg L^{-1}, which was above the GBRMPA threshold, and a mean turbidity of 2.3 NTU (Table 2.13). Maximum turbidity was 18 NTU, reached during a period of elevated turbidity during the March flood of the Tully River (Figure 2.12). 17% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and 15% exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

In the Burdekin NRM Region, three reef locations had instruments deployed.
Due to instrument problems, data for Pelorus Island were only retrieved from one deployment from October to December 2007 (Figure 2.12). The overall mean chlorophyll concentration in that record was 0.33 µg L^{-1}. Mean turbidity was 0.5 NTU, the lowest in the Burdekin Region, with a maximum daily value of 0.9 NTU. 16% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and none exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

River (Figure 2.14). 54% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and only 4% exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

Daydream Island had a mean chlorophyll concentration of 0.48 µg L^{-1}, which was just above the GBRMPA threshold and the lowest value in the Region, and a mean turbidity of ~1.3 NTU (Table 2.13). Maximum turbidity was ~8 NTU, reached briefly mid February, coinciding with the second major flood peak of the Pioneer River (Figure 2.14). Chlorophyll was above the GBRMPA chlorophyll trigger value for most of October but show very little response to the flood. 25% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and only 2% exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

Pine Island had a mean chlorophyll concentration of 0.73 µg L^{-1}, which was above the GBRMPA threshold, and a mean turbidity of ~1.7 NTU, both the highest values in this Region (Table 2.13). Chlorophyll was above the GBRMPA chlorophyll trigger value for most of the record with 91% of the daily means exceeding this value. Maximum turbidity was ~7 NTU and was variable and slightly elevated from late December to mid February, the latter part coinciding with the flood of the Pioneer River (Figure 2.14). However, only 4% of daily means exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

Three reef locations in the Fitzroy NRM Region had instruments deployed.
Barren Island had a mean chlorophyll concentration of 0.5 µg L^{-1}, which was above the GBRMPA threshold, and a mean turbidity of ~0.4 NTU, both the lowest values in this Region (Table 2.13). Turbidity was slightly elevated and more variable from late December to late February with a maximum of ~3 NTU (Figure 2.15). Chlorophyll was highest after the second flood peak of the Fitzroy River mid to late February (Figure 2.15). 44% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values but none exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

Humpy Island had a mean chlorophyll concentration of 0.56 µg L^{-1}, which was above the GBRMPA threshold, and a mean turbidity of ~1 NTU (Table 2.13). Chlorophyll was above the GBRMPA chlorophyll trigger value for most of October and in mid February, coinciding with the second major flood peak of the Fitzroy River, during which also the maximum turbidity of ~6.5 NTU was briefly reached (Figure 2.15). 35% of the daily means in the record exceeded the GBRMPA chlorophyll trigger values and only 2% exceeded the suggested 5 NTU limit for coral photo-physiological stress (Table 2.13).

Pelican Island had a mean chlorophyll concentration of 0.76 µg L^{-1}, which was above the GBRMPA threshold, and a mean turbidity of ~7.3 NTU, both the highest values in this Region and of all 14 locations (Table 2.13). Daily means of chlorophyll were above the GBRMPA chlorophyll trigger value on 60% of the days, during the flood event for 77 days in a row. Maximum turbidity was ~37 NTU and values were very variable for most of the record with more elevated values from late December to late March, encompassing the major flood of the Fitzroy River (Figure 2.15). 46% of daily means exceeded the suggested 5 NTU limit for coral photo-physiological stress, with 30 days above this threshold during the flood event (Table 2.13).