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Fresh and Marine Water Quality in the Mackay Whitsunday Region

2004/05 to 2006/07

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Fresh and Marine Water Quality in the Mackay Whitsunday Region 2004/05 to 2006/07

The event monitoring component of the Integrated Monitoring Program, Mackay Whitsunday Healthy Waterways: A community-assisted approach

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EXECUTIVE SUMMARY

The Mackay Whitsunday region covers an area of approximately 9000 km^2 along the central Queensland coast. The major rivers of the region include the Proserpine, Andromache/O'Connell and Pioneer, with a number of smaller streams also discharging directly to the Great Barrier Reef (GBR) lagoon and western Coral Sea. Major land uses in the region consist of natural forest in the headwaters, rangeland beef grazing in the mid course, and sugar cane and urban areas on the lower floodplain and coastal areas. Significant water quality issues in the region have been recorded in previous studies, and include fish kills associated with low dissolved oxygen, mangrove dieback and high concentrations of nutrients and herbicide residues in major stream flow events.

The Mackay Whitsunday Natural Resource Management (MWNRM) Group has produced a Natural Resource Management Plan for the region which aims to protect, and where necessary, restore both natural and cultural assets. The *Mackay Whitsunday Healthy Waterways Integrated Monitoring Program* is an initiative of the MWNRM Group, with a vision of improving water quality and aquatic condition throughout the region, and links community initiatives with industry and government groups. The current event-based water quality monitoring project (this report) is a component of that Program, and was designed with the following objectives:

i. Quantify pollutants generated by the major land uses in rainfall runoff events in the Mackay Whitsunday region.
ii. Quantify pollutants discharging to the inshore areas of the GBR lagoon
iii. Quantify the extent of dispersion of terrestrial pollutants during runoff events into the GBR lagoon, and hence assess risk to marine ecosystems
iv. Obtain baseline data to support regional and local target-setting, and water quality improvement plans.
v. Increase the awareness of water quality and aquatic ecosystem issues within the Mackay Whitsunday region through involvement of the community in event sampling.

One of the important features of the project is the emphasis on community involvement. Sampling was conducted with the assistance of landholders, local government and state government staff, students, and other interested individuals.

A total of 26 sites were selected to represent water quality from sub-catchments dominated by a single land use (forest, sugar cane, grazing and urban) and mixed land-use catchments. A number of runoff events were sampled at each site over three wet seasons (2004/05 to 2006/07). Marine sampling was undertaken following three of these events – January 2005, January 2007 and February 2007. Total suspended solids, nutrients and pesticide residues were the pollutants measured at most sites. The extent and nature of plumes in the marine environment were quantified using aerial overflight mapping and/or satellite imagery. Nutrients were analysed to give full speciation and the pesticides targeted were those known to be used in the region, particularly a number of herbicides.

Results from the monitoring indicate the following conclusions based on the objectives stated previously:

Total suspended solids, nutrients, pesticide residues and organic compounds from event flows were measured from dominant land-use sub-catchments and mixed land-use catchments. In comparison to forest sub-catchments:

- Sugar cane dominated sub-catchments exported high concentrations of nutrients (particularly dissolved inorganic nitrogen (DIN; median 624 µg N/L) and filterable reactive phosphorus (FRP; 203 µg P/L)) and herbicides (particularly diuron; 3.2 µg/L), and moderate to low concentrations of total suspended solids (TSS; 46 mg/L),
- Grazing dominated sub-catchments exported moderate concentrations of TSS (82 mg/L), nutrients and low concentrations of some herbicides.
- Urban sub-catchments exported high concentrations of total phosphorus (TP; 292 µg P/L), and FRP (185 µg P/L), and moderate concentrations of trace organics (some herbicides and petroleum hydrocarbons).
- Two developing urban sub-catchments produced very high TSS concentrations (median and maximum of 278 and 6000 mg/L, respectively).

With respect to pollutants discharging to the inshore areas of the GBR lagoon, the monitoring program found:

- Three events that discharged from the Pioneer River to the inshore area (total flow 702,000 ML) had an event mean concentration of 198 mg/L for TSS (load of 139,100 tonnes), 390 µg N/L for DIN (274 tonnes), 1.12 µg/L for diuron (786 kg) and 0.58 µg/L for atrazine (407 kg).
- High concentrations (exceeding known effect levels and guidelines) of a number of herbicides in flood plumes.
- High concentrations of nutrients in flood plumes resulted in a massive phytoplankton bloom in January 2005.
- A visible flood plume (algal bloom) persisted in coastal waters and surrounded the inshore reef systems for up to 10 days in January 2005, and diuron persisted above detection levels for at least 9 days in February 2007.
- Inshore marine ecosystems were subjected to multiple effects (synergistic or antagonistic) of a mixture of herbicides, nutrients, TSS, low salinity and organic matter.

Significant baseline information to support local and regional target-setting, and water quality improvement plans was collected in the monitoring program, and showed that:

- Sugar cane sub-catchments produced low TSS concentrations similar to forest sub-catchments, a result of the adoption of green cane trash blanketing and improved farm management practices. Hence, the sugar industry is well placed to meet any future TSS water quality targets. In developing urban and grazing sub-catchments, there is greater potential for improvements in TSS concentrations.
- Sugar cane sub-catchments generated greater nutrient and herbicide concentrations than forest sub-catchments. The soluble inorganic forms of nutrients that are more bioavailable and have a greater potential to impact on

riverine, coastal and marine ecosystems, are constituents that require water quality targets to be set.

This has been the first study to comprehensively examine herbicide concentrations in flood plumes within the GBR. The data show that herbicide application in GBR catchments is an important management issue. The data also show that, for the flood plumes monitored, offsite transport from agricultural catchments poses a significant risk to the health of inshore corals, seagrass and mangroves.

1 INTRODUCTION

The Great Barrier Reef (GBR) World Heritage Area is a relatively pristine environment with high conservation value located adjacent to areas of intensive agriculture and increasing urbanisation (Shaw and Müller 2005). Coral reefs in coastal GBR waters have been degraded, and this degradation has been attributed to elevated levels of sediment and nutrients discharged from regional rivers (Van Woesik *et al.* 1999). There is also a concern that herbicide residues in river plumes are damaging mangroves, seagrass beds and corals (Duke *et al.* 2003; Haynes *et al.* 2000a; Jones *et al.* 2003).

The Mackay Whitsunday region has an array of natural resource assets, namely extensive intact wetlands, riparian areas near natural forest ranges, headwater streams and waterfalls, considerable areas of mangroves, fish habitats, seagrass, and inner shelf reefs that support an important tourism industry. The major rivers of the region include the Proserpine, O'Connell/Andromache and Pioneer with a number of smaller streams that also discharge directly to the GBR lagoon. The water quality of the region's rivers, and other Queensland coastal streams, is of concern (Arthington *et al.* 1997; Brodie 2002; Furnas 2003). More significantly, it has been highlighted with the introduction of the Reef Water Quality Protection Plan (The State of Queensland and Commonwealth of Australia 2003), which aims to address diffuse pollution from broadscale land-uses and reduce the delivery of these pollutants to the GBR lagoon.

Land uses in the Mackay Whitsunday region that influence event-based water quality consist of natural forest in the headwaters, rangeland beef grazing in the mid course, and sugar cane and urban areas on the lower floodplain and coastal areas. An earlier twenty-month survey of the Whitsunday area could not discern the impacts of specific land uses on ambient water quality (Faithful 2003). The finding in this study that filterable reactive phosphorus and total phosphorus concentrations exceeded default trigger values (ANZECC and ARMCANZ 2000) for all land uses, including 'reference' forest sites supports the need for regional water quality guidelines as stated in the ANZECC document. A more recent twelve month study found elevated nutrient and herbicide concentrations in intensively cropped catchments when compared to bushland catchments (Galea *et al.* 2008b).

The Mackay Whitsunday Natural Resource Management (MWNRM) region is one of fifteen Natural Resource Management regions in Queensland. The MWNRM Group has produced a Natural Resource Management Plan for the region in partnership with community, industry, agency, and indigenous groups. The plan aims to protect, and where necessary, restore assets both natural and cultural (MWNRM 2005). It will also form the main mechanism of implementing the Reef Water Quality Protection Plan in the region, particularly Strategy I6 – *As part of the coordinated water quality monitoring program support and improve community and industry based water quality information collection programs in high-risk Reef catchments* (The State of Queensland and Commonwealth of Australia 2003).

The *Mackay Whitsunday Healthy Waterways Integrated Monitoring Program* is an initiative of the MWNRM Group, with a vision of improving water quality and aquatic condition throughout the region, and links community initiatives with industry

and government groups. The program aims to assess waterway issues and measures change in the condition of water resources through baseline (monthly), event-based (flood; this project) and community-based ambient (volunteer) waterway monitoring. Information collected ensures that sound science underpins aquatic resource management and water quality target setting in the region. An initial component of the program was to deliver a "State of the Waterways" report (Brodie 2004). This report concluded that aquatic ecosystem health in the region varied from poor in the intensively used urban and agricultural areas of the lower Pioneer and Proserpine floodplain, to almost natural in the forest catchments of Repulse and Flaggy Rock Creeks.

River flow in the tropical catchments of Queensland is seasonally variable and characterized by infrequent, high-intensity flood events during the wet season (Mitchell *et al.* 1997). The runoff processes, and subsequent transport of catchment-based pollutants associated with such floods can lead to rapid and substantial export of these pollutants via rivers to the coastal zone. For this reason, as part of the *Mackay Whitsunday Healthy Waterways Integrated Monitoring Program,* event-based water quality monitoring was undertaken in 2002 and 2003 (Mitchell *et al.* 2005) and more extensive monitoring in 2004/05 (Rohde *et al.* 2006). In the current event-based monitoring program, which builds on the 2004/05 data, monitoring sites were situated in sub-catchments dominated by a single land use, catchments representing mixed land-use, and throughout three flood plumes in coastal waters. This has been the first study to comprehensively examine herbicide concentrations (and exposure times) in flood plumes within the GBR.

Prior to the 2004/05 sampling, there existed some uncertainty as to the extent of the transport and potential influence of catchment-derived pollutants in the GBR system, especially in the Mackay Whitsunday region. Previous studies of flood plumes and coastal sediment transport off the Burdekin River (Devlin *et al.* 2001; McCulloch *et al.* 2003; Orpin *et al.* 2004; Pfitzner *et al.* 2004; Wolanski and van Senden 1983), the Wet Tropics rivers (Devlin *et al.* 2001; Devlin and Brodie 2005; McCulloch *et al.* 2003) and the Fitzroy River (Brodie and Mitchell 1992; Devlin and Brodie 2005) have revealed exposure of inshore ecosystems including coral reefs and seagrass to a range of nutrients associated with dissolved and fine particulate fractions of the river load. However, such studies had not previously taken place off Mackay Whitsunday rivers. Van Woesik *et al*. (1999) demonstrated a gradient of terrestrial influence away from the mouths of the Proserpine and O'Connell Rivers through the Whitsunday Islands, and associated this with recent loss of reef-building capacity on the reefs nearest the rivers. The plumes from flooding rivers in the Mackay Whitsunday region associated with cyclone Justin rainfall (March, 1997) were aerially mapped, but no sampling occurred (Devlin *et al.* 2001).

One of the unique features of the water quality sampling program has been the emphasis on community involvement. Water quality sampling was conducted by a network of community volunteers located throughout the region. Sampling was conducted with the assistance of landholders, local government and state government staff, students, and other interested individuals. Through these partnerships, the community across the region can share ownership of the results, and develop a better understanding of the key drivers influencing water quality in the region. On-going water quality monitoring, including plot-scale monitoring, will build our

understanding further and identify key catchment areas, land uses and land management practices that most contribute to elevated levels of suspended sediment, nutrients and herbicides in the Mackay Whitsunday region.

This report outlines the results and main findings of the event-based water quality monitoring component of the *Mackay Whitsunday Healthy Waterways Integrated Monitoring Program.* Other components, reported separately, include the ambient community volunteer network (Galea *et al.* 2008a), monthly baseline monitoring (Galea *et al.* 2008b) and plot-scale monitoring of cane management practices (Masters *et al.* 2008). These reports are supporting documents for the Mackay Whitsunday region's water quality improvement plan (Drewry *et al.* 2008).

The objectives of the event-based water quality monitoring project, and this report, were to:

i. Quantify pollutants generated by the major land uses in rainfall runoff events in the Mackay Whitsunday region.
ii. Quantify pollutants discharging to the inshore areas of the GBR lagoon.
iii. Quantify the extent of dispersion of terrestrial pollutants during runoff events into the GBR lagoon, and hence assess risk to marine ecosystems.
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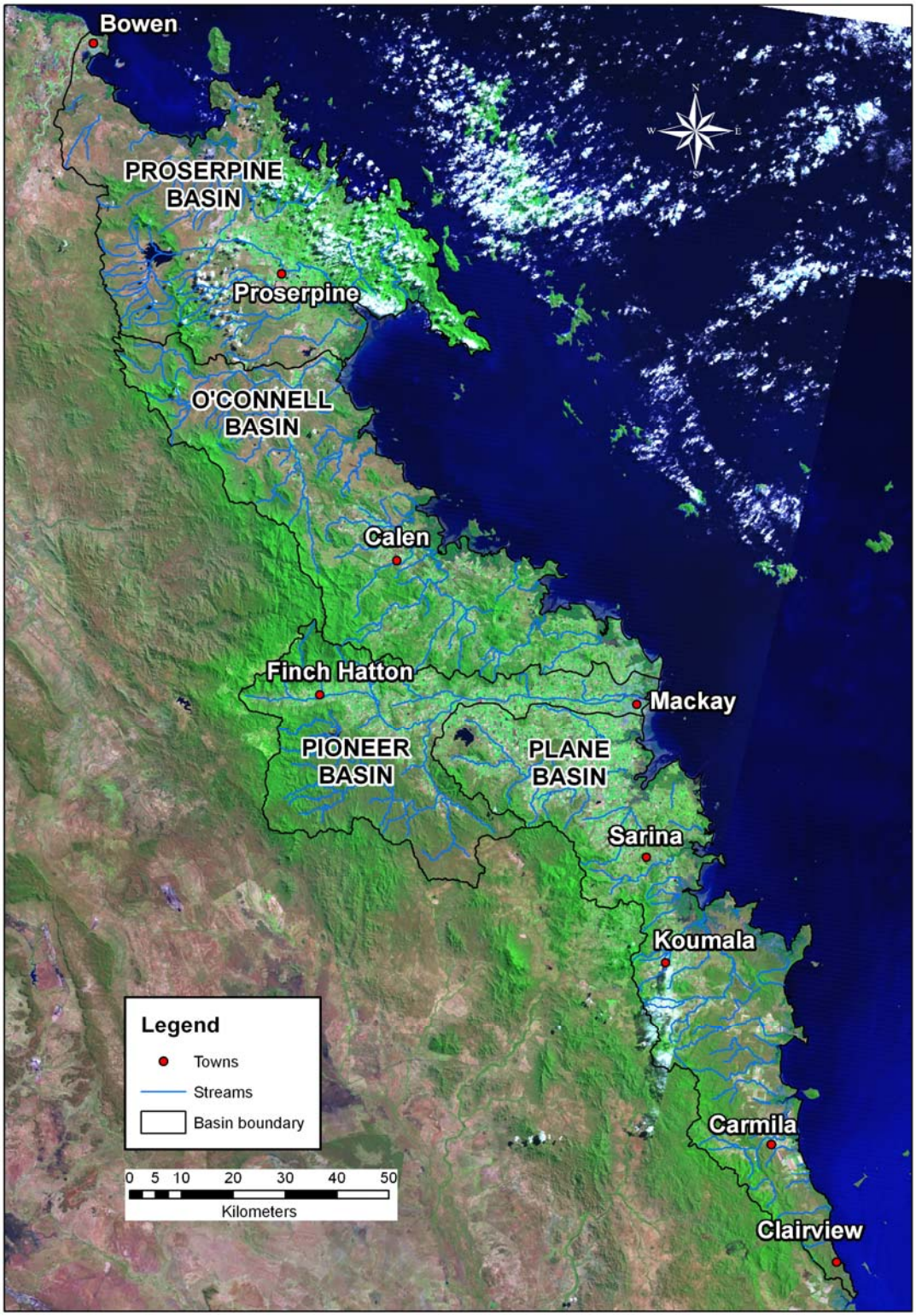

Figure 1 Mackay Whitsunday region showing major basins, towns and streams

2 DESCRIPTION OF REGION

The Mackay Whitsunday region comprises an area of approximately 9000 km^2, and occupies a narrow coastal strip on the central coast of Queensland extending from Bowen in the north to Clairview in the south, a distance of approximately 300 km (Figure 1). At its widest point, centred around Mackay, the region is about 80 km wide and extends from the Coral Sea and the GBR in the east, to the headwaters of the Pioneer River in the west.

The region's climate is humid and tropical, with hot wet summers and cooler dry winters. Annual rainfall varies significantly from approximately 3000 mm per year in elevated sections of the coastal ranges to less than 1000 mm in other inland areas (refer to Figure 6f). Most of the region's rainfall (~70%) occurs between December and March.

The region consists of four major hydrological basins.

Proserpine and O'Connell basins
Major rivers (Basins 122 and 124 of the Australian Water Resources Council (AWRC)) are the Proserpine (regulated by Peter Faust Dam) and O'Connell/Andromache Rivers, which discharge separately into Repulse Bay. These rivers drain the western part of the basin, including the higher slopes of the Clarke Range and Eungella National Park. Other smaller streams include Myrtle Creek, Impulse Creek, Airlie Creek, Waite Creek and Gregory River. Land use in the lower catchments is dominated by sugar cane, with significant areas of beef grazing and existing/developing urban (townships of Proserpine and Cannonvale/Airlie).

Pioneer basin
This basin (AWRC Basin 125) consists of that area draining into the Pioneer River. Major tributaries include Finch Hatton Creek, a tributary of Cattle Creek, and Blacks Creek. The upper catchment area drains the Clarke and Connors Ranges. Land uses in the middle and lower reaches of the basin are dominated by sugar cane, with significant areas of beef grazing. The city of Mackay is situated near the mouth of the Pioneer. The river is highly regulated with one dam (Teemburra), one off-stream storage (Kinchant Dam in the Plane basin) and three weirs (Mirani, Marian and Dumbleton).

Plane basin
This basin (AWRC Basin 126) consists of a number of small streams flowing directly to the GBR lagoon between Mackay and Clairview. Major streams include Sandy Creek, Plane Creek, Rocky Dam Creek, Basin Creek, and Carmila Creek. The northern streams drain flatter agricultural areas, whereas smaller streams to the south drain the Connors Range. Sugar cane dominates the flat coastal areas, but beef grazing is also a dominant land use. The major urban area in the basin, Sarina, is situated on the lower reaches of Plane Creek. Plane Creek is highly regulated, with one dam (Middle Creek Dam) and four weirs.

A more detailed description of the region, including mean annual rainfall and land use maps for each basin have been reported previously (Rohde *et al.* 2006).