



Australian Government

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Program 7: Halting and Reversing the Decline of Water Quality

Project 3.7.2: Connectivity and risk: Tracing materials from the upper catchment to the reef (Objective c – JCU extension component – coral coring in the Mackay Whitsunday and Fitzroy River regions)

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Task 1: Material tracing in the marine environment: An assessment of changes in water quality in the Mackay Whitsunday region using coral core records (Stephen Lewis, ACTFR, JCU)

Coral core records provide excellent insights into changing water quality in the Great Barrier Reef (GBR) lagoon over the last 150 years (McCulloch *et al.* 2003; Marion *et al.* 2006; Jupiter 2006; Lewis *et al.* 2007). However, the majority of research efforts have focused on terrestrial runoff from the Burdekin River catchment (e.g. McCulloch *et al.* 2003; Lewis *et al.* 2007) with limited focus on Wet Tropics catchments (e.g. Barron, Johnstone, Tully, Herbert) and Mackay Whitsunday catchments. These catchments drain intensive agricultural areas of significant fertiliser application (sugarcane, bananas) which contrasts the Burdekin catchment which is dominated by cattle grazing. This land use difference is reflected by the terrestrial runoff in these catchments; the Burdekin is a significant contributor of sediments to the GBR lagoon (e.g. Furnas 2003; Brodie *et al.* 2003; 2004; Bainbridge *et al.* 2006) whereas the other catchments export elevated dissolved nutrient concentrations (Rohde *et al.* 2006).

Recently coral proxies (Ba, Y, Mn) have provided evidence of increased sediment export to the GBR lagoon from the Burdekin River catchment (McCulloch *et al.* 2003; Lewis *et al.* 2007) while nitrogen isotopes are being developed to quantify increases in nutrient loads (Marion *et al.* 2005). The nitrogen isotope signature in corals has been applied in the Mackay Whitsunday Region using a transect of cores off the Pioneer River (Marion *et al.* 2006). Changes in the isotopic signature were correlated with increased fertiliser application in the Pioneer River catchment, although additional studies are required to validate these findings. The nitrogen isotopic composition in corals varies naturally across the GBR shelf (Sammarco *et al.* 1999). An opportunity exists to quantify changes in water quality in the GBR lagoon as well as to validate/improve coral proxies along a water quality gradient through the Whitsunday Island Group (from Repulse Bay to Hook Island). This gradient has been recognised by van Woesik *et al.* (1999) and Fabricius *et al.* (2005) and is thought to be the result of recent (~last 100 years) changes in terrestrial runoff from the Proserpine, O'Connell and Pioneer Rivers. This study will complement similar research into geochemical records of a "pristine" inshore coral reef in Princess Charlotte Bay (S. Jupiter pers. comm.,

2006) and expand on other studies from the Mackay Whitsunday Region (Jupiter 2006; Marion *et al.* 2006).

An important question to resolve is whether the observed water quality gradient through the Whitsunday Island Group is primarily a response to suspended sediment or nutrient (particularly nitrate) inputs. It is unclear as to whether the changed light conditions observed along the transects from the river mouths out to the mid-shelf reef (Cooper *et al.*, *Catchment to Reef* draft paper) are associated with the direct effects of increased sediment from the rivers or organic suspended matter generated by increased nutrient flux from the rivers. As land management of these two issues (increased suspended sediment and increased nitrate export) is complex, we need to understand which issue is more important before land use management can be prioritised. Nutrient inputs will also lead to a phytoplankton bloom (Rohde *et al.* 2006) and probably a shift in phytoplankton species composition. This shift will have major implications for other parts of the trophic chain (e.g. crown of thorns starfish larval survival; Brodie *et al.* 2005). Sampling phytoplankton species will allow the first quantification of this shift for the Great Barrier Reef.

This project will be linked with existing MTSRF projects including coral cores in the path of freshwater plumes Wet Tropics (Professor M. McCulloch) and water quality proxies in the Mackay Whitsunday Region (Dr K. Fabricius). The project is also linked to flood plume sampling by the Mackay Whitsunday NRM group in this region for the 2004-2005 water year (Rohde *et al.* 2006) as well as from the 2006-2007 wet season (K. Rohde *et al.* in prep).

This project will also investigate the reliability of coral proxies in coral cores which are influenced by the Fitzroy River. A previous study suggests that the coral Ba/Ca ratio may not provide a reliable proxy of suspended sediment export (J. Marshall pers. comm.) and this study will examine these claims and attempt to develop other proxies of suspended sediment export. In particular, the coral Y concentration has shown promise as a proxy for suspended sediment transport.

Project Results

Preliminary results from the 2007 coral core collection

Six short cores were selected from the September 2007 coral coring in the Mackay Whitsunday region and analysed by laser ablation ICP-MS (LA-ICPMS) for trace elements. The six cores with the best growth records were chosen to represent each site cored in the region including Repulse Island, Haslewood Island, Cid Island, North Molle Island and Hook Island. Two separate cores from different coral colonies were analysed from Repulse Islands to examine the reproducibility of the trace element record. The LA-ICPMS data from all the cores have now been processed and an accurate chronology for the REP-71A has been established. The Sr/Ca, U/Ca and B/Ca ratios were used as proxies of sea surface temperature to establish this chronology and typically show clear summer (troughs)-winter (peaks) trends (Figure 1). The Ba/Ca ratios (proxy of bulk sediment export) show some variability over this ~40 year period and an apparent increasing trend over time (Figure 2). The 'spikes' of the 1991 and 1979 large floods from the O'Connell River are evident in the record.

The nitrogen isotope analysis of two coral slices from the Repulse Islands is planned for November-December 2008 provided that the coral slices can be prepared in time. Stephen Lewis made two separate trips to Canberra (in May and October 2008) to ensure that the measurement of nitrogen isotopes in corals is possible on the machine at the Research

School of Biological Sciences, ANU. It was established that at least three grams of sample material was required for reliable nitrogen analysis on this machine. This result was achieved through a thorough experimental design process.

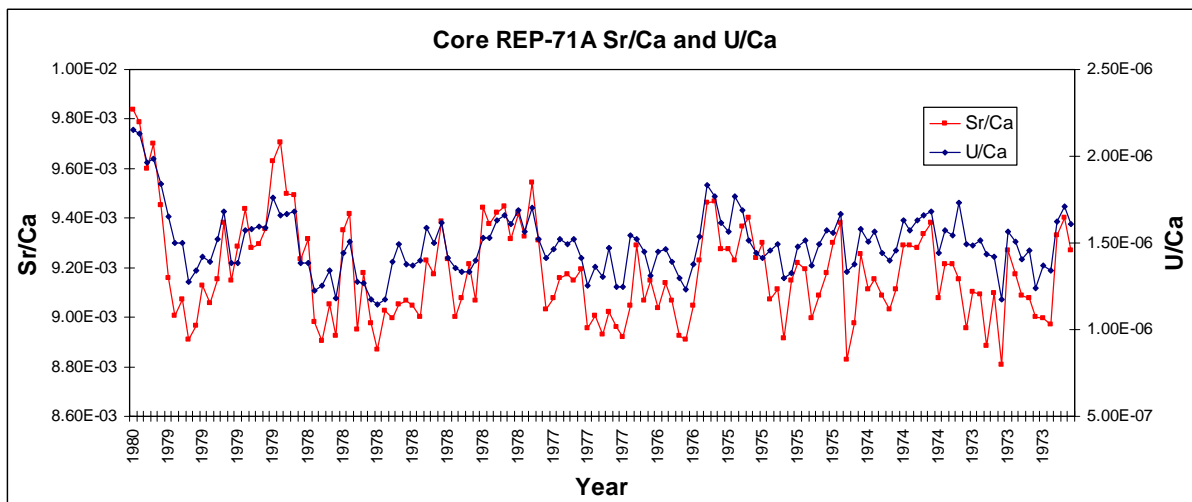


Figure 1: Coral Sr/Ca and U/Ca ratios have been used in the REP-71A core to establish a reliable chronology. The troughs in the record coincide with summer while the peaks in the record relate to the peak of winter.

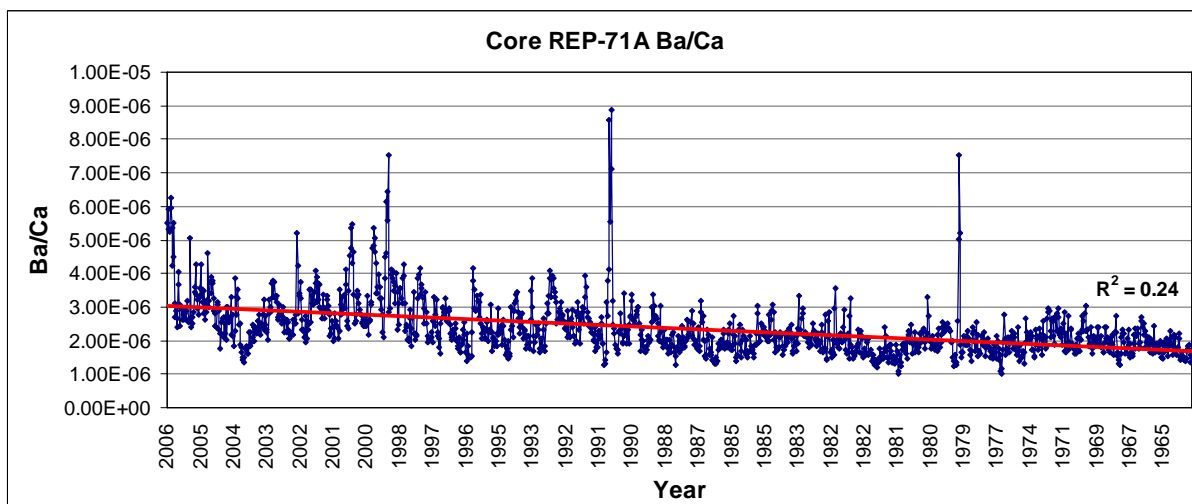


Figure 2: The coral Ba/Ca record shows some variability over time with an apparent increasing trend. The large flood events in 1991 and 1979 are clearly evident in the Ba/Ca record.

Collection of coral cores in the Mackay Whitsunday region 2008

A total of 15 coral cores were collected in the Mackay Whitsunday region in June-July 2008. Long cores (~1.5 m in length) were collected from Shaw Island, Haslewood Island and Cobham Reef. The best of the cores have been mounted and are ready for slicing and preparation for laser ablation trace element analysis. The collection of long coral cores is a considerably more difficult task than short coring. Long coral coring requires heavier

equipment and another research vessel to perform the task. In addition, several of the cores were found to be contaminated by mollusk borers or the growth records became off-axes due to the coral being overturned at some stage. These problems only became obvious when coring was conducted.

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Project problems and opportunities

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Communications, major activities or events

Communications have continued with Dr Hillary Stuart-Williams and Dr Stephen Clayton (ANU) about the measurement of nitrogen isotopes in coral cores. Stephen Lewis made two trips to Canberra to ensure that the measurement of nitrogen isotopes in corals was possible. Arrangements have been made with Eric Matson (AIMS) to slice the coral cores from the June-July 2008 trip and to help sample the Repulse Island corals for nitrogen isotopes. Frequent contact has been made with Prof Malcolm McCulloch to arrange additional LA-ICPMS analyses of the Whitsunday coral cores.

Stephen Lewis will continue to process the Whitsunday Island cores and establish a reliable chronology from the laser ablation analysis. The 2008 cores will be sliced and prepared for laser ablation analysis in 2009. Two coral slices from the Repulse Islands will be sampled and analysed for nitrogen isotopes in November-December 2008. A product resulting from the trace element and nitrogen isotope analyses of the Repulse Island cores is planned for 2009.