# NERP Tropical Ecosystems Hub

## Research Highlights 2012

National Environmental Research Program

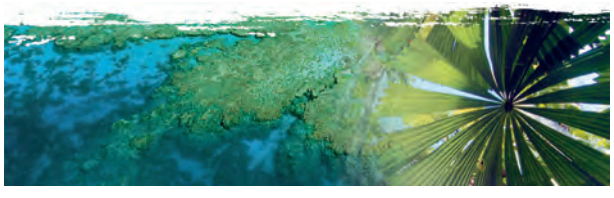
TROPICAL ECOSYSTEMS hub

## Contents




Australian Government

Department of Sustainability, Environment, Water, Population and Communities

## From the Science Leader

The NERP Tropical Ecosystems Hub is just over a year old. As shown by these half dozen examples, Hub researchers are generating new knowledge to support better environmental outcomes in Queensland's Wet Tropics region, Torres Strait, and the Great Barrier Reef.

The Great Barrier Reef is an Australian icon. The GBR Marine Park is acknowledged widely as providing the best managed marine ecosystem in the World. Many research projects in the TE Hub are designed to support this aspiration. Despite this, the NERP TE Hub delivered a sobering message through its analysis of long-term monitoring data on reef condition. Since 1985, GBR coral cover has shown an alarming and unsustainable decline on reefs south of Cooktown that contrasts with the relative stability of coral cover on reefs adjacent to Cape York. When these results were shared with the managing agencies, the Australian and Queensland governments extended major programs designed to halt and reverse the decline of coastal water quality, provided immediate industry assistance for direct action against crown-of-thorns starfish, and initiated tactical research into starfish control through the NERP Emerging Priorities Program.

While COTS outbreaks may be a symptom of degraded water quality, another Hub project is producing compelling evidence of historical change in coastal coral reefs that predates monitoring. Accurate dating of skeletal fragments left on the surface or buried in the sediments shows that coral communities in some coastal locations experienced a rapid transition in the middle of the last Century that was unprecedented in the previous millennium. This provides some of the most compelling evidence (the smoking gun) to justify and sustain the major public investments that will be required to improve the quality of water from GBR catchments. It also provides salutary lessons for Torres Strait communities about the importance of maintaining local water quality even though a preliminary hazard assessment by the Hub showed that the risks there arise from different though not insignificant issues.

The rapid development of north Queensland during the 20th Century has also created many environmental legacies on the land (habitat loss, weeds, pests, and threatened native species). The NERP TE Hub is seeking new knowledge on many of these old problems in order to support evidence-based decision making that protects and conserves our valuable and biodiverse Wet Tropics landscapes. In this first report, we highlight three different examples ranging from the discovery of missing frogs to integrating climate change action into regional planning.

The common element in all of the examples is the direct contact between Hub researchers and research users, whether they come from government agencies, industry, and/or community. This reflects the Hub's focus on communicating knowledge through the shortest direct path to practical and policy levers affecting environmental outcomes.

## Frogs vs fungus: are the frogs winning?

Ten frog species disappeared from the upland rainforests of the Wet Tropics and Eungella regions during outbreaks of amphibian chytrid fungus in the late 1980s and early 1990s. This loss represented 25% of the frogs endemic to the Wet Tropics, and all of the Eungella endemics. Four of these frog species had been found only in the uplands and were presumed extinct as they had not been sighted, despite intensive searches.

Enter Rob Puschendorf[1] and Conrad Hoskin of James Cook University, whose project (NERP TE Hub 3.3: Targeted surveys for missing and endangered frogs), was inspired by the rediscovery of one of the "extinct" species, the Armoured Mistfrog, (Litoria lorica) in dry sclerophyll forest close to the mountain rainforest streams from which the frog vanished 20 or more years previously. Interestingly, the population appeared to be coexisting with the chytrid fungus, suggesting the development of resistance or perhaps tolerance.

As Dr Puschendorf says:

"A number of frog species seem to be able to coexist with the amphibian chytrid fungus to some degree at higher elevations; where once they were wiped out. However they are not immune and can develop fatal disease. We know that if the right environmental conditions occur we will see dead frogs in the field"

What the rediscovery of the Armoured Mistfrog did was raise the possibility that other frogs might also be out there, overlooked because surveys have focused on rainforest, not the adjacent drier zones. Thus it was to these ecotonal areas (the margin between the rainforest and dry forest) that searches were refocused.

Several more species have now been found, with apparent recolonisation of rainforest frogs into upland rainforest areas. For example, the torrent tree frog (Litoria nannotis) has expanded its range at Cloudy Creek (Paluma), recolonising upstream from where it disappeared more than two decades ago. The same species is also in good numbers at sites on Clohesy River (Lamb Range) where it was absent or rare five years ago, and a small number of the Australian Lace Lid Frog (Nyctimystes dayi) are also starting to appear. This strongly suggests recovery of frog populations on these streams over recent years. Surveys of the Eungella region have also found the endangered Eungella Torrent Frog (Taudactylus eungellensis) has been persisting in good numbers at Rawson's Creek.

While the work continues, these rediscovered populations have to be protected. In order to assist in ongoing protection, Rob Puschendorf and Conrad Hoskin have supplied information to protected area managers on the recreational sites which are impacting or have the potential to impact on endangered frog populations.

[1]Now at Plymouth University, U.K.

*Litoria lorica*. Image: Robert Puschendorf (JCU)

Dead *Litoria Nannotis* juvenile, most likely from chytrid
Image: Robert Puschendorf (JCU)

Left to right: Jane Waterhouse, Johanna Johnson, Jon Brodie, Paul Rai, Matt Broadbeck, Will Higham. Photo taken on Saibai Island

## Hazard assessment for water quality threats to Torres Strait marine waters, ecosystems and public health

The Torres Strait marine environment is of national and international significance characterised by critical coral reef and seagrass habitats, many species of fish, invertebrates and turtles, and one of the largest population of dugong globally. The region faces global pressures, such as increasing shipping traffic, demand for peak oil and impacts associated with climate change that could have complex impacts on Torres Strait's environmental assets, particularly when combined with local pressures. An understanding of the impacts of local and regional activities, such as shipping and coastal development, on water quality in the region is of primary importance to the Torres Strait, particularly with respect to influences on marine foods, human health, marine ecosystems and ecological processes.

Jon Brodie and his team at TropWATER (James Cook University) have recently completed a NERP TE Hub-funded project describing and assessing pollution sources and associated hazards to the Torres Strait's marine ecosystems and public health. The analysis was facilitated by the development of a new hydrodynamic model that mapped local circulation patterns and micro-currents in the region in a subproject led by Professor Eric Wolanski.

The project has been completed and several key conclusions and recommendations made.

It is apparent that transit of large ships and the predicted increase in shipping traffic through the region presents the greatest threat; ship grounding and oil spills would be catastrophic for small island and reef communities, and the pollutants could remain in the region for some time as the water exchange in and out of the Torres Strait is both limited and complex.

Other large scale water quality threats include wastewater containing heavy metals from mines in Papua New Guinea that discharge into the Fly River in Papua New Guinea (PNG). Future similar scale pollutant sources from adjacent areas are expected to include gas platforms, oil palm plantation development, the Daru Port development, other mines in PNG or West Papua, and land clearing including that for proposed forestry operations. Modeling and remote sensing data suggest that the northern islands of Boigu, Saibai, Erub and Ugar are most likely to be affected by any such pollutants due to the predominant easterly movement of water originating from the Fly River, and prevailing coastal ocean currents. That said; the Daru Port development could change locally generated pollutant sources and result in westward movement of pollutants along the southern coast. Boigu, Sabai and other low-lying islands also face the added threat of storm surge inundation and sea-level rise due to climate change.

Finally, general waste management and localised wastewater management issues were identified within the Torres Strait region, the latter particularly with respect to marine sewage outfalls. Here the need for remedial actions included further training for sewerage treatment plant operators; annual outfall monitoring in conjunction with Torres Strait Regional Authority (TSRA) Land and Sea Management Rangers to assess condition and integrity; waste recycling at coral cays, and litter monitoring on islands adjacent to the main shipping route.

Further monitoring recommendations developed for consideration by the TSRA focused on analysis of remote sensing imagery to assess the movement of river discharges from PNG into the region, supported by in situ monitoring of water quality to assess water quality status in the northern Torres Strait. The focus would be on turbidity, with monthly data acquisition and annual assessments. Other activities would include the assessment of metals in marine waters and in biota at several northern locations, marine sewage outfall assessments, marine litter and ghost net monitoring, and more detailed oil spill risk assessment.

## Dealing with climate change on a regional scale

The effects of climate change are starting to become apparent, confirming the need for a portfolio approach to the issue that includes mitigation, adaptation and enhanced resilience. The scale at which any of these are effective is determined by many factors, but regionally-prioritised land management practices have the potential to deliver both significant abatement and bio-sequestration opportunities, and improved landscape resilience.

In that vein, Dr Allan Dale of the Cairns Institute has just completed a NERP TE Hub project focused on governance, planning and effective application of ecosystem service markets to secure climate change adaptation and landscape resilience in Far North Queensland. For those not familiar with the term, ecosystem services are: "the benefits people obtain from ecosystems"[1].

In short, the transformation of natural assets such as soil, plants and animals, air and water into things we value. Examples include the provision of safe drinking water by a stable catchment and natural filtration processes, or recreational fishing opportunities by a healthy reef ecosystem, through to the provision of soil through natural breakdown of dead plant material (the product of sunlight, carbon and nitrogen) by fungi, worms and bacteria. If we allow our natural assets to decline, so will the benefits; if we look after and maintain our natural assets, we will benefit from greater returns[2].

This idea has evolved to the extent that over the last few years there has been a growing interest in the use of market forces to drive conservation and restoration, with markets providing a link between people willing to pay for actions that improve and protect the environment and those who can take those actions[3]. The trade in carbon is a good example of one such market.

A major output of Dr Dale's project was a comprehensive "Practical Manual" developed for Natural Resource Management (NRM) Bodies on regional scale planning and carbon market integration. Arrangements are in place for the completion of State-wide training based on the manual, to be delivered across Queensland regional NRM bodies in early 2013.

Strategic riparian rehabilitation. Image: Terrain NRM

Allan Dale, Cairns Institute, JCU

Three theory-based publications have also been completed on NRM governance systems and planning for adaptation and ecosystem service market guidance. These publications have influenced the development of regional principles across north Queensland for the next generation of regional NRM planning and hence the region's Stream II research proposal for the Wet Tropics Cluster. Stream II funding is part of a $24.16M package released by DSEWPaC to support climate change planning and the updating of regional NRM Plans to guide mitigation and adaptation activities in the landscape[4]. Specifically, "Stream II" funding supports research institutions to develop regional-level information, in the form of scenarios describing impacts of climate change (water, temperature, storms) which can be used for medium-term regional NRM land-use planning[4].

Preliminary project work and the original discussion paper are continuing to influence national NRM Body and Commonwealth Government policy and the recently established principles for next generation NRM plans by the Australian Government and Queensland Regional Group's Collective.

[1] www.unep.org/maweb/en/Synthesis.aspx

[2] www.ecosystemservicesproject.org/html/overview

[3] www.environment.gov.au/biodiversity/publications/ecosystem-services-nrm-futures/pubs/ecosystem-services.pdf

[4] www.reefcatchments.com.au/nrm-planning-for-climate-change

## Half the Great Barrier Reef's coral lost in the last 27 years

Twenty-eight years ago AIMS began annual surveys of the Great Barrier Reef, with a broad-scale look at 250 reefs. Since 1985, approximately 100 reefs have been inspected every year by snorkel divers towed on manta boards and since 1993, forty-seven of those reefs have been subjected to more detailed survey by SCUBA divers. To date, more than 2,700 days have been spent at sea, and around $50M invested, to keep a weather eye on our World Heritage icon. And the news is not good.

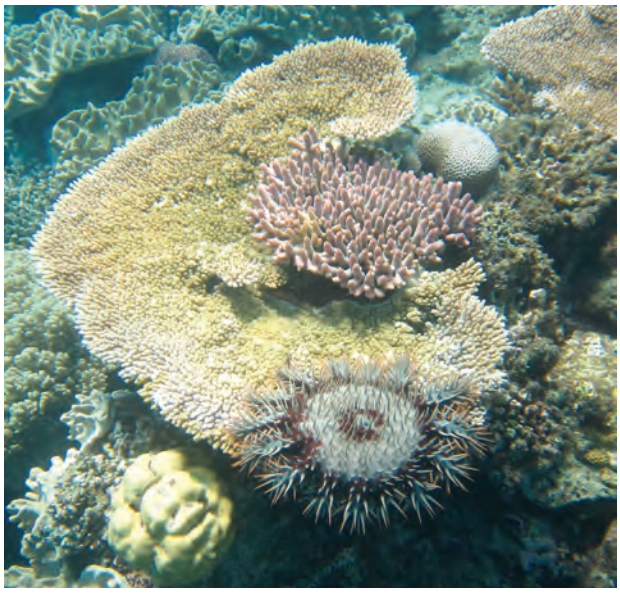
In 2011, 27 years of monitoring data were analysed and showed that coral cover on inshore reefs close to the developed coast has declined by half since 1985, with no change found on reefs adjacent to the undeveloped Cape York coast. Causes include cyclones (48% of the effect), crown-of-thorns starfish (COTS) (42%), and coral bleaching (10%). Coral diseases and other factors (e.g. recovery impaired by poor water quality) may have also contributed to the overall decline but were not studied.

COTS outbreaks have also been linked to poor water quality, with terrestrially-derived nutrients from diffuse agricultural sources, particularly during the wet season, thought to enhance larval growth of the coral-eating starfish. If the past is a reliable guide to the future and none of the major pressures are decreased, total coral cover could be as low as 5% by 2025; just 12 years from now.

The research has important ramifications for the management of the Great Barrier Reef Marine Park. In 2012, the Australian Government provided $1.43 million to support COTS control, in partnership with GBR tourism operators. A further $300,000 was allocated to the Australian Institute of Marine Science for tactical research into COTS outbreaks and potential control measures.

www.nerptropical.edu.au/publication/project-51-journal-27-year-decline-coral-cover-great-barrier-reef-and-its-causes

Manta board surveys conducted by snorkel divers. Image: AIMS



A crown-of-thorns starfish eating one of its favourite types of corals, tabulate Acropora. Crown-of-thorns starfish are not usually found out in the day, until they are large adults, or the density of starfish is high. Image: LTMP

Detailed SCUBA surveys. Image: AIMS

## Human impacts, climate change and the GBR: an historical perspective

The coral reefs of the GBR (Great Barrier Reef) are in decline. Long-term losses in abundance, diversity and habitat structure have resulted from a combination of overfishing, nutrient and sediment loading, disease, crown of thorns starfish outbreaks and the effects of climate change. These changes have occurred in the GBR catchment since Europeans settled the Queensland coastline in the mid-19th century but it has been difficult to make the link between terrestrial discharge, water quality, global warming, ocean acidification and coral decline on a regional scale, and the contribution of anthropogenic influence to the disturbance regimes of inshore reefs remains highly controversial[1].

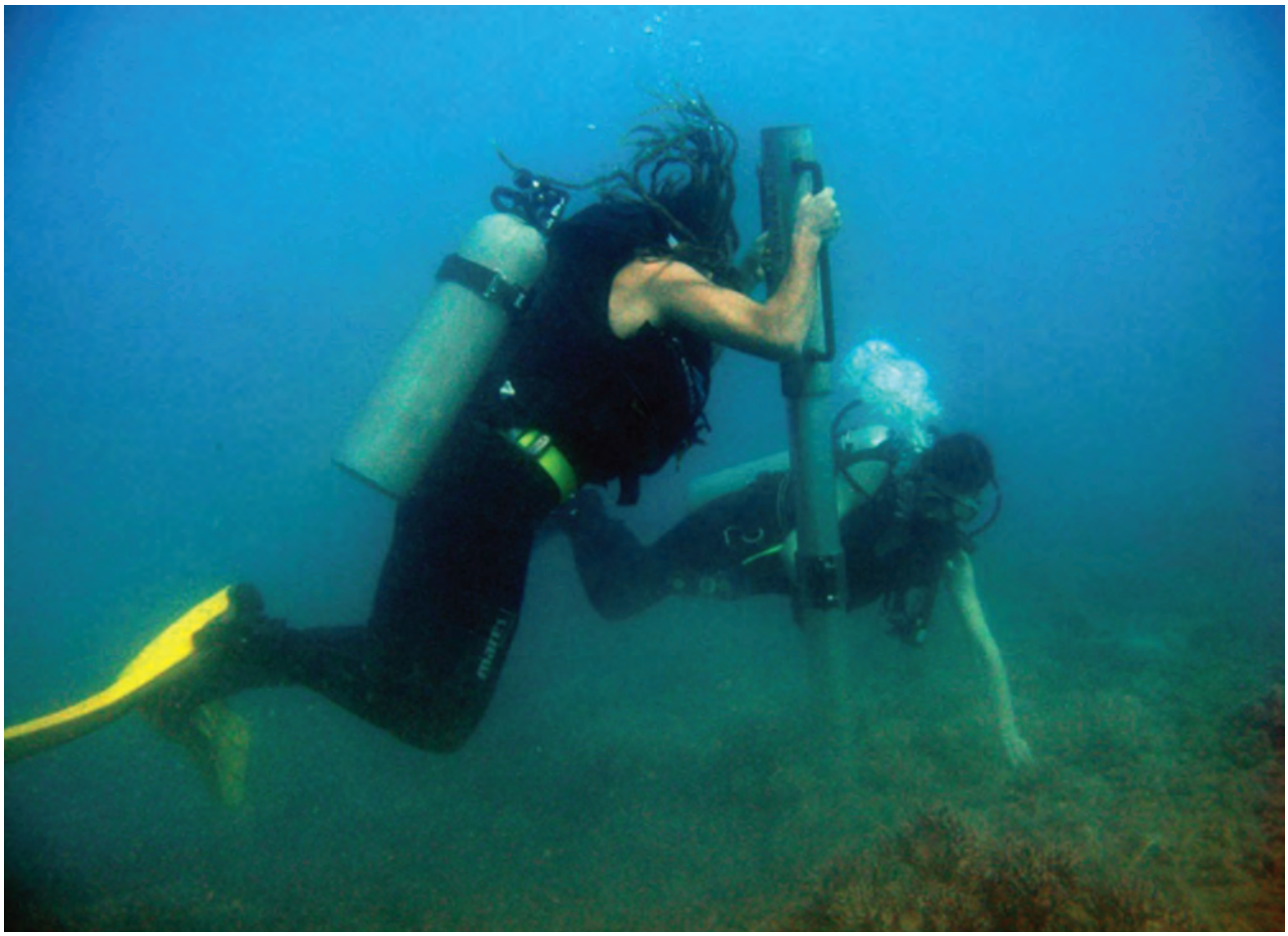
Associate Professor Jian-Xin Zhao, Professor John Pandolfi and large team of collaborators from the University of Queensland, James Cook University, University of Western Australian and the Great Barrier Reef Marine Park Authority (GBRMPA) are looking to disentangle the impact and trend of recent European settlement from natural and human-induced global climate change, principally by correlating in time major ecological changes with specific physical environmental drivers.

Coral cores revealed a collapse of branching corals (Acropora spp) between 1930 and 1950. This happened in relatively benign climatic conditions at Palm Island and was unprecedented during the previous 1500 years despite significant climatic variability and a high super-cyclone frequency during that period; both not seen since European settlement. This led the researchers to conclude that the lack of Acropora recovery between 1930 and 1950 could only be attributable to the dramatic increase in sediment delivery to the GBR lagoon post-European settlement, causing chronic stress and predisposing corals to minor acute impacts.

Coral growth parameters determined for a large number of cores collected from massive Porites heads off the Townville coast also indicated a distinctive cross-shelf pattern in the coral-growth response in the last 50 years. That and the long-term decrease in coral calcification rates observed in the inshore area suggested stronger effects of terrestrial run-off and higher sea-surface temperature variability. The cores also show the effects of the strong bleaching event in 1998.

In the absence of detailed long-term monitoring programs prior to the 1980s, this and similar work provide important baseline information on the dynamics of reef communities: their composition, and how, when and why they have changed. Such knowledge has been used to inform the GBRMPA Strategic Assessment as it provides an accurate and stable baseline from which to formulate management decisions.

[1]www.uq.edu.au/ecology/gbr-project



To understand how coral communities have changed over time we use reef cores collected at approximately 5m depth by a team of divers using a percussion coring technique. These cores can retrieve up to 3000 years of reef development. Image: University of Queensland

## Species in conflict: Cassowaries and flying foxes, and humans

Monitoring is a fundamental component of the management of threatened species, and is of particular importance when those species come into direct conflict with humans and their interests. In such circumstances up-to-date information on population status, trends and distribution become key inputs into decision making, with good data critical to the process. As our population grows and spreads in the Wet Tropics the endangered southern cassowary (Casuarius casuarius), and the vulnerable spectacled flying fox (Pteropus conspicillatus) are increasingly the focus of demands for management, and of bitter debates, often with financial and legal implications. Questions relating to population sizes, trends and distribution are central to decision making and conflict resolution processes, and there are also issues around the adequacy of monitoring data used for management decision making.

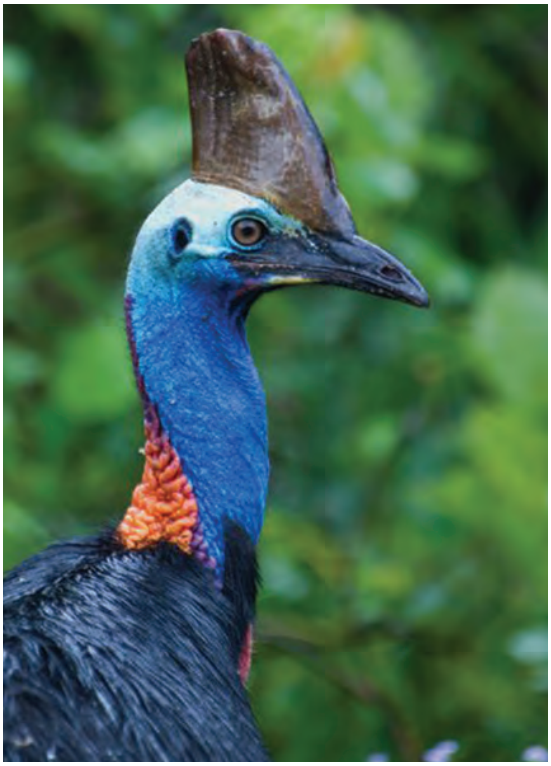
Dr David Westcott of CSIRO is employing recently developed methods to monitor abundance and distribution of these two species, intending to provide estimate of population sizes and structure, distributions, and dynamics to facilitate management decisions.

The project (3.4) is in its early stages. Analysis of cassowary dung samples has indicated that individuals can be successfully discriminated on the basis of genetic differences, with 30 individuals identified from 41 samples processed in the first surveys. A further 70 samples are currently being analysed from the second bout of surveys. This result has significant implications for species monitoring, and will be further tested in 2013 with a study of captive animals. Dr Westcott's monthly flying-fox surveys have also shown that numbers peak in November and December.

The research is extremely topical and has created a lot of public and government interest with presentations given to the Australian Hendra Committee Risk Assessment Advisory Group (DAFF) on flying-fox monitoring and movements and its implications for disease risk assessment and to the combined Biosecurity Queensland/Biosecurity NSW Hendra meeting (Woolongbar, NSW) on flying-fox monitoring and implications for epidemiological studies. Presentations were also given at the Hendra virus and Flying-fox workshop in Byron Bay, the Emerging Infectious Diseases Symposium and the Wet Tropics Management Authority Scientific Advisory Committee. This project regularly provides data to local government to assist in decision making about 'problem' camps and to the Queensland Government with respect to Hendra outbreaks. The project has also become the template for the National Flying-fox Monitoring Program, a collaboration between the Commonwealth, Queensland, New South Wales, Victorian, South Australian and ACT Governments and CSIRO.

A report on cassowary research progress and database development was presented to the WTMA Cassowary Recovery Team, made up of local councils and State and Commonwealth government agencies, regional NRM bodies, research organisations, Indigenous interests, landholders, cassowary conservation groups and tourist industry representatives.

The work continues, with data collection on abundance, distribution and population structure with a view to identifying the drivers of spatial dynamics for these species, both considered to be indicators of rainforest health. These patterns will be used to inform decision making with respect to agricultural, urban and future disease risk.



Cassowary (*Casuarius casuarius*). Image: David Westcott

Little-red flying-foxes (*Pteropus scapulatus*) are about half the size of other Pteropus. They are sometimes found roosting in a corner of a spectacled flying-fox camp, usually in tight clusters. Image: David Westcott

Three spectacled flying-foxes (*Pteropus conspicillatus*) asleep. Image: Adam McKeown

The Reef and Rainforest Research Centre (RRRC) administrates the Australian Government's National Environmental Research Program Tropical Ecosystems (NERP TE) Hub.

Reef & Rainforest
RESEARCH CENTRE

PO BOX 1762, Cairns QLD 4870
07 4050 7400
enquiries@rrrc.org.au
**www.rrrc.org.au**