National Environmental Research Program

TROPICAL ECOSYSTEMS hub

NERP Tropical Ecosystems Hub

GBR Biodiversity Program Update, December 2012

Compiled by RRRC

Front Cover: Close up of crown of thorns starfish's spines (Acanthaster planci) from Forrester Reef. The spines of the crown-of-thorns are extremely sharp and toxic. *Image: LTMP*

Project 1.1: Monitoring status and trends of coral reefs of the GBR

Project Leader: Dr. Hugh Sweatman

Project Background

This project surveys 47 reefs from north of Cooktown to South of Gladstone in alternate years. These reefs have been surveyed repeatedly since 1993. In 2012, the reefs in the far southern GBR and the far northern GBR were surveyed.

Project Progress

Reefs in the southern GBR include those in the Pompey, Swains and Capricorn-Bunker sectors. These reefs have generally been damaged by large cyclones in the past few years and are in the early stages of recovery. Coral cover is generally low (<10%) except for the outer reefs in the Swains that seemed to have avoided the worst damage. Crown-of-thorns starfish were present in 'incipient outbreak' densities in the Pompey sector, which appear to be the last remnant of the southward wave that began around Lizard Island in 1994.

Reefs in the far northern GBR include those in the Cooktown/Lizard Island sector. These reefs have higher coral cover because of less severe cyclone activity in recent years, but nearly all inshore and mid-shelf reefs that were surveyed had outbreaks of the crown-of-thorns starfish in densities that were at 'incipient outbreak' or 'active outbreak' levels. Coral cover can be expected to decrease markedly on these northern reefs in the next two years or so.

Project 1.2: Marine wildlife management in the Great Barrier Reef World Heritage Area

Project Leaders: Professor Helene Marsh and Dr. Mark Hamann

Project Background

This project is focused on a) connectivity and ecosystem role of green turtle and dugong and b) gathering information on the distribution of inshore dolphins of the northern GBRWHA.

Project Progress

The green turtle and dugong component of the project involves stable isotope analysis, genetics and tracking. Stable isotope markers C and N were analysed from the skin of 200 turtles from three latitudes. Early indication supports omnivory in juvenile green turtles. The study of the genetic structure of juvenile green turtles from Low Isles found that 95% of turtles from that site are from the southern GBR population and there were very few turtles from the northern GBR population. And satellite tags were attached to turtles in Shoalwater Bay and Cardwell. Results are in the early stage of analysis.

The inshore dolphin component of the project involved travelling to 14 locations in Cape York Peninsula to scope the potential for traditional and local knowledge mapping workshops. The primary aim of discussions were to ascertain the sighting distribution of inshore dolphins and dugongs and the willingness, capability and feasibility

While cyclones cause a lot of damage to some parts of a reef other areas, are unscathed. Here branching coral continues to proliferate at Broomfield Reef. By using the manta tow technique, the LTMP can assess which areas of a reef are most impacted by disturbances like COTS and storms, as the perimeter of each reef is surveyed in this technique. *Image: LTMP*

of traditional owners and other community members in collaborating with JCU to record their traditional and local knowledge. Other community members included six Indigenous Ranger groups, recreational fishers, yachters, tourism operators and environmental scientists. Workshops will be conducted in 2013.

Project: 5.1: Understanding diversity of the GBR: Spatial and temporal dynamics and environmental drivers

Project Leaders: Dr. Glenn De'ath and Dr. Katharina Fabricius

Project Background

This project aims to map the diversities of biota and environments of the GBR and relate biotic diversity to spatial, environmental and temporal drivers.

Project Progress

There have been two major scientific advances is this work:

- Development of a new statistical method for analysing diversity. The method is called the multinomial diversity model (MDM) and the first publication of this work is completed (De'ath, 2012). The work is ongoing and will be applied widely within the project. The application of the MDM to studies of diversity will benefit from that basis and experience. The application of this model should enable researchers and managers to make better informed and consistent judgments about the degree of spatial and temporal drivers influencing diversity.
- Using Long Term Monitoring Plan data, changes in GBR coral cover in space and time were assessed. This work is now completed, and has resulted in one high profile publication (De'ath et al, 2012), reporting that GBR coral cover is now half of what it was 27 years ago. The identified and quantified main causes of change are cyclones, crown-of-thorns starfish, and coral bleaching, with 48%, 42% and 10% of the losses attributable to these three causes. Other disturbances, such as coral diseases for which no data were available, may have also contributed to the decline, and were factored in through by calculating present rates of recovery.

Project 6.1: Maximising the benefits of mobile predators to GBR ecosystems: the importance of movement, habitat and environment

Project Leader: Dr. Michelle Heupel

Project Background

This project aims to define the extent of movement of mobile predator species in coastal and reef ecosystems. It aims to determine: the factors that lead to changes in residency and movement; the role that active mobility plays in connecting populations; and the appropriate management tools.

Project Progress

To date a series of 48 acoustic receivers have been deployed, downloaded and maintained. Acoustic transmitters have been deployed in 30 stingrays at Orpheus Island; and 124 coral trout, 16 red emperor and 62 sharks in the Capricorn Bunkers to contribute to and enhance the results obtained adjacent to Townsville. Within the Townsville reefs 127 individuals have been fitted with transmitters including: 8 bluespot coral trout, 60 common coral trout, 19 red throat emperor, 3 giant trevally, 11 bull sharks, 17 grey reef sharks, 4 sliteye sharks, 4 silvertip sharks and 1 whitetip reef shark. Data will be downloaded in late 2012-early 2013 to facilitate movement analysis. In anticipation of these data, analytical tools have been in development, including calculating activity space based on distance moved around a reef platform correlated with depth utilisation and three-dimensional home ranges. This will determine movement in and out of areas subject to different zoning.

A tagged blacktip reef shark fitted with an acoustic transmitter. *Image: Michelle Heupel*

Project 6.2: Drivers of juvenile shark biodiversity and abundance in inshore ecosystems of the Great Barrier Reef

Project Leader: Dr. Colin Simpfendorfer

Project Background

This project examines the importance of different types of inshore habitat and marine park zoning for shark biodiversity, and how environmental factors affect how these nursery areas function.

NERP survey team checking the gillnet for sharks. Gillnets and longlines are used in the survey project to catch sharks across a range of sizes. *Image: Peter Yates*

Project Progress

The 2011/12 summer survey in nine bays along the central GBR coast caught 529 elasmobranchs. Results indicate that there is considerable variation in the elasmobranch fauna between bays, in part resulting from differences in environmental parameters. The next phase of the project – intensive season surveys of five of the bays – have been running since April, and so far has almost completed three full survey rounds. Other project activities, including the acoustic monitoring components in Cleveland Bay and at Orpheus Island are proceeding with a suite of tags released in target species, including blacktip reef sharks, Australian sharpnose shark, creek whalers and Australian blacktip sharks.

The variable assemblage of elasmobranchs caught in nearshore waters is dominated by requiem sharks (whaler, hammerhead and weasel families), but abundance of each species varies between the bays surveyed. Theoretical work undertaken has shown that this diversity in abundance between bays can be a successful strategy employed by species to ensure stable numbers of animals are produced across the region through time. The management implication of such as strategy is that the condition of the range of nursery areas needs to be maintained to enable such a strategy to be successful. Further research being undertaken with the intensive seasonal surveys will provide more data to test these preliminary observations.

Project 6.3: Critical seabird foraging locations and trophic relationships for the Great Barrier Reef

Project Leader: Dr. Brad Congdon

Project Background

This project aims to identify and map foraging grounds for boobies and shearwaters; overlay satellite derived information on biophysical oceanographic characteristics; quantify prey availability; and establish linkages between areas, processes and anthropogenic activity.

Project Progress

Results to date include:

- Analyses of 2012 shearwater tracking data confirmed that many important seabird foraging sites are outside of the GBRMP and that foraging activity overlaps significantly with known commercial fishing activity.
- Tracks encompassing the 7-8 month winter migration period (May to October) have been obtained for wedge-tailed shearwaters. These tracks identify the oceanic region and resource base used by this population during the non-breeding season.
- Foraging tracks for marked boobies in the Swain Reefs show consistency of foraging location among individual boobies. Overlap occurs between booby foraging sites and those used by wedge-tailed shearwaters breeding at Heron Island during the chick-rearing season (Feb-Apr 2012).
- Birds returning from migration have accepted artificial nest boxes deployed on Heron Island. The uptake of these nest boxes represents a major advance for our future data acquisition, as they provide birds with a safe, secure and reliable site in which to breed over the entire nesting season.
- In addition to previously planned activities researchers in this program have been involved in an extensive population survey of seabirds nesting in the Capricorn-Bunker group of Islands in January 2013.

A common coral trout (*Plectropomus leopardus*) being cleaned of parasites by cleaner wrasse (*Labroides dimidiatus*) in the Whitsunday Islands. Coral trout are the primary targets of the hook and line fishery on the Great Barrier Reef (GBR). The abundance and average size of coral trout has been shown to increase within protected green zones on the GBR. *Image: David Williamson*

Project 8.2: Do no-take marine reserves contribute to biodiversity and fishery sustainability? Assessing the effects of management zoning on inshore reefs of the GBR Marine Park

Project Leaders: Professor Garry Russ and Dr. David Williamson

Project Background

This project aims to assess the effects of multiple use management zoning of the GBR on reef fish, fishery target species, coral health and benthic communities. It also assesses usage patterns of recreational fishers and compliance with zoning regulations. The project has carried out Underwater Visual Census surveys on fringing reef slopes at Magnetic Island and in the Whitsundays. The surveys were conducted in zones that are open to fishing and those that are closed to fishing.

Project Progress

The Magnetic Island surveys found average live hard coral cover to be 20.7%. Coral cover was significantly higher in zones open to fishing, which was attributed to the orientation of the sites relative to the storm front of Cyclone Yasi. The project found no significant difference between sites open or closed to fishing with regard to densities and biomass of coral trout, although densities were generally low relative to previous surveys.

The Whitsundays survey found average live hard coral cover to be 38.8% with no significant difference between zones. However, the prevalence of coral disease was significantly greater in sites that are open to fishing. Sites that were closed to fishing had significantly higher densities and biomass of coral trout. There were more larger coral trout in zones that were closed to fishing in the 1980s than those closed to fishing in 2004. The project also collected abandoned fishing line from all sites and found no significant difference between sites open or closed to fishing. However, removing the lines creates a baseline from which to measure re-accumulation at these sites.

Project 8.3: Significance of no-take marine protected areas to regional recruitment and population persistence on the GBR

Project Leaders: Professor Geoff Jones and Dr. David Williamson

Project Background

The aim of this project is to apply genetic parentage analysis and biophysical modelling to assess the role of

marine reserve networks for coral trout (*Plectropomus spp*.) conservation and fisheries on a regional scale.

Project Progress

In this reporting period the project has completed the development of new genetic methods to accurately assign juveniles that are progeny of parents in marine reserves ("green" zones). This entailed developing and testing a new set of 24 hyper-variable microsatellite genetic markers for assessing parent-offspring relationships in both *P. leopardus* and *P. maculatus*. Validation results have demonstrated that the marker set is able to successfully discriminate the two *Plectropomus* species and identify parent-offspring relationships in natural populations. The project also completed the planned large-scale sampling program in which the DNA of adult and juvenile coral trout was sampled at three locations (Percy, Keppel islands and Capricorn-Bunker island groups). This will enable assessment of larval export from marine reserves over a distance of up to 200 kilometres. Observed dispersal patterns will be compared with predictions from a biophysical model that takes into account water currents and the behaviour of coral trout larvae.

Project 9.1: Dynamic Vulnerability Maps and Decision Support Tools for the Great Barrier Reef

Project Leader: Dr. Ken Anthony

Project Background

This project aims to develop a framework for a dynamic spatial vulnerability model for the GBR.

Project Progress

The results of this project are a significant step towards fulfilling a long-standing request from reef managers to understand the vulnerability of the GBR spatially and temporally. During the past six months the team has advanced the modeling of coral reef resilience and vulnerability substantially by functionally integrating spatial and temporal environmental data from multiple sources into a spatially explicit model for coral risk i.e. generating dynamic vulnerability maps. As part of this framework the project has developed a novel resilience metric that enables managers assess to what extent different actions on manageable stressors (management levers) can offset vulnerability. Our method builds on resilience modeling (developed by Mumby and Anthony) in which key ecosystem processes including recruitment, growth, competition and mortality are directly informed by a suite of environmental variables and disturbance types.

Calibrated results for the major reef framework builders have been achieved, including structural corals of the genus *Acropora*, and the project has defined vulnerability as the risk that coral cover is lost over a management time frame (e.g. 10 years). Preliminary coral vulnerability layers for the recent past have ben modelled, integrating risks from coral bleaching, COTS, cyclones and nutrients/turbidity. The model skills demonstrated by these outputs provide confidence that the tool, following further calibration and testing, will be effective in supporting management planning and decisions under complex environmental scenarios including climate change.

Project 9.2: Design and implementation of Management Strategy Evaluation for the Great Barrier Reef inshore

Project Leader: Dr. Cathy Dichmont

Project Background

This project aims to use a stakeholder driven approach to qualitatively integrate an understanding of key drivers of change in the inshore GBR ecosystem and it's human uses, with an emphasis on biodiversity and inshore multi-species fisheries management.

Sunset over Middle Island (foreground) and Great Keppel Island in the Keppel Island group, southern GBR Marine Park. The fringing coral reefs surrounding Middle Island have been protected within a no-take marine reserve (green zone) since the late 1980's. *Image: Tane Sinclair-Taylor*

Black noddies in a Pisonia tree at Wilson island. Sea birds such as black noddies are important to coral cay vegetation: transporting nutrients from ocean to land. *Image: Mirjam Maughan, JCU*

Project Progress

The project has worked in collaboration with GBRMPA and other end users to determine case study areas for the development of qualitative models that will allow stakeholder input to develop a joint understanding of the inshore system, including human interaction with it. The primary geographical focus has been the Mackay region, which has formed the project's initial case study. Further consideration will focus on the Bowen/Burdekin region.

The case study region was based on input from a sub committee of the Mackay Local Marine Advisory Committee and completed draft qualitative models of seagrass, coastal development and creeks with governance.

Project 9.3: Prioritising management actions for Great Barrier Reef islands

Project Leaders: Professor Bob Pressey and Dr. Mirjam Maugham

Project Background

The aim of this project is to develop an explicit decision-making framework for cost effective management actions across the islands of the Great Barrier Reef. A sub-region for the decision support model was selected. Islands in the selected sub-region are diverse and include inshore islands in the Keppel region to the Capricorn-Bunker group and offshore in the Swains group.

Project Progress

The technical framework and data sources for the project were explored at a three-day workshop on Magnetic Island in October 2012. Further progress identifying features and data sources was made during a reconnaissance trip November 2012, including project team leaders, island managers and scientists, visiting 19 islands in the study area. During this trip it was also agreed to apply the technical framework initially on a subset of islands to test the framework and perform a sensitivity analysis. The outcome of those tests will inform which data gaps are most important to fill using workshops and interviews eliciting expert judgment. A journal article on 'Island biosecurity for the GBR' (an identified key issue for managers) was also drafted on the reconnaissance trip.

The project team is now compiling data on our selected islands in the southern GBR, a method to elicit expert information to fill data gaps is being developed, the decision model is being designed, and journal papers are being drafted.

Project 10.1: Social and economic long-term monitoring programme

Project Leader: Dr. Nadine Marshall

Project Background

This project aims to develop world-class social and economic monitoring program that will directly inform the management of the Great Barrier Reef.

Project Progress

The project has established a number of Working Groups involving a range of participants from various sectors of the community and identified end users. These groups

have identified the type of primary data that the project should seek to collect through surveys and existing secondary data sets that the project can access. Through this process, the project has identified the need to report on: i) the relationship between people and the Great Barrier Reef, ii) human and community wellbeing, (iii) indirect drivers of change, and (iv) direct drivers of change. The project has developed a 12-point framework for monitoring the relationship between people and the Great Barrier Reef and is currently in the process of identifying the important indicators of human and community wellbeing.

Project 10.2: Socio- economic systems and reef resilience

Project Leader: Professor Natalie Stoeckl

Project Background

This project aims to gain an improved understanding of the manner in which GBR ecosystem services are valued, including an intrinsic value for characteristics of the GBR, such as natural beauty. It also seeks to understand how external socioeconomic pressures can inadvertently diminish those values. To gain this understanding, surveys targeting residents and tourists were carried out.

Project Progress

To date, the project has entered data from 1,040 visitors, from which some preliminary observations can be made. Most visitors go to the mainland beaches at least once during their stay (85%), with the average number of beach visits exceeding two. Very few visitors (just 11%) went fishing. The median number of nights spent along the coast near the GBRWHA was six. Median daily expenditure was $106 (mean = $135). Most money was spent on accommodation and at cafes/bars/restaurants. When asked about the 'importance' of various factors when deciding whether to come to the region or not, the highest scores were given to clear oceans, healthy coral reefs, and healthy reef fish. When asked to indicate how they would respond to various hypothetical 'changes' to the GBRWHA, respondents reacted most negatively (e.g. with a large number of people saying that they would not have come at all) to the prospect of 'twice as many oil spills, ship groundings and wastes spills from ports', the 'ocean changing from clear to murky'; or having 'twice as much rubbish on the beaches'. When asked to indicate if they would be willing to pay to help 'fix' various threats to the reef, visitors indicated that they would be willing to pay $10 (median response) each time they visited to improve water quality; they were willing to pay $5 (median response) to protect top predators or reduce the risk of shipping accidents.

Project 13.1: e-Atlas

Project Leader: Dr. Eric Lawrey

Project Background

This project aims to further develop the e-Atlas, which is a website, mapping system, and a set of data visualisation tools for presenting research data in an accessible form to allow greater use of the information.

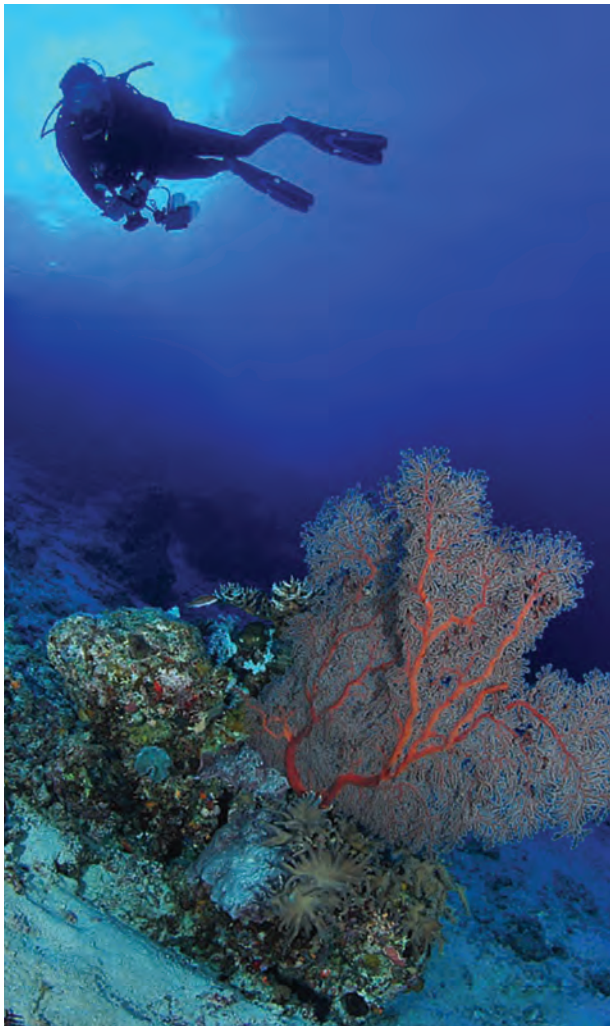
Project Progress

The design of the e-Atlas has been enhanced to more comprehensively capture, warehouse and communicate the outputs of the research projects. To achieve this there have been a range of designed changes to the e-Atlas systems. Most of these key system changes are now in place. New datasets emerging from the NERP TE will be recorded using these new standards and systems, and over the next six months legacy content will be migrated to ensure all content in the e-Atlas is handled in a consistent manner.

The new metadata system is now in production and is integrated into the mapping system and front page of the website. It now contains records for over 30 datasets. Existing dataset records in the website are now deprecated and will be migrated into the new metadata system.

The e-Atlas mapping software (AtlasMapper) has been extended to include improved support for ArcGIS data sources, location search, additional base maps and support for creating print maps. It was also used to create a portal for WTMA to highlight their Wet Tropics vegetation dataset.

In August 2012 a workshop in the Torres Strait was run to prioritise datasets that should be prepared from CSIRO historical collection of spatial research data for the region. During this reporting period the e-Atlas has started integrating content from the NERP-TE projects. Project pages have been setup and several datasets have been fully prepared and available online for download and accessible through the mapping system.



Clear ocean provides excellent diving experiences. *Image: Matthew Curnock*

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