National Environmental Research Program

TROPICAL ECOSYSTEMS hub

NERP Tropical Ecosystems Hub

GBR Biodiversity Research Snapshot
July to December 2013

Compiled by RRRC

ABOUT THE NERP

National Environmental Research Program

The overall objective of the National Environmental Research Program is to improve our capacity to understand, manage and conserve Australia's unique biodiversity and ecosystems. It will achieve this through the generation of world-class research and its delivery to Australian environmental decision makers and other stakeholders. The Program features five research hubs, including the Tropical Ecosystems Hub.

The Tropical Ecosystem Hub

The Tropical Ecosystem Hub is a $61.89m investment that address issues of concern for the management, conservation and sustainable use of the World Heritage listed Great Barrier Reef and its catchments; tropical rainforests, including the Wet Tropics World Heritage Area; and the terrestrial and marine assets underpinning resilient communities in the Torres Strait.

Great Barrier Reef Biodversity Node

The TE Hub supports 38 research projects, with fifteen focused on Biodiversity within six Programs:

- Historical and current condition of the Great Barrier Reef
- Cumulative impacts on benthic biodiversity
- Movements and habitat use by marine apex predators
- Effectiveness of spatial management on the Great Barrier Reef
- Decision support systems for Great Barrier Reef managers
- Socio-economic value of Great Barrier Reef goods and services

About this publication

This publication is a snapshot of the progress within the projects of the NERP TE Hub for the period July to December 2013.

For further information on the TE Hub and its structure please go to: www.nerptropical.edu.au

Front Cover Image: Wilson Island from the sea. *John Hicks*

CONTENTS

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

Prof. Helene Marsh & Dr. Mark Hamann, JCU

Project Background

Marine mammals (dugongs and dolphins) and turtles are facing threats from human activities such as fishing, pollution and coastal development. This project is using monitoring, genetics, satellite tracking and remote sensing techniques to determine the distribution and status of inshore dolphins in the northern GBRWHA; to estimate the size of the dugong population along the GBRWHA coast; and to better understand the role of green turtles and dugongs in coastal ecosystems. The project is also working with Traditional Owners to protect these species, all of which have high conservation and cultural value. The purpose of the research is to provide information for the conservation of these species.

Project Progress

Capacity building of Indigenous ranger groups within the GBRWHA to independently monitor their sea country regions continued with consent of the Girringun Aboriginal Corporation (Girringun Aboriginal Rangers) and the Yintjingga Aboriginal Corporation (Lama Lama Rangers). Collaborative activities include:

- Girringun Aboriginal Rangers dedicating one day per month of their work schedule toward dedicated 'Western style' inshore dolphin and dugong boat-based surveys.
- Lama Lama Rangers (in collaboration with JCU) completed their first boat-based scientific survey of inshore dolphin and dugongs of their sea country region (Princess Charlotte Bay).
- Training in marine mammal identification and capacity building in terms of boating operations and marine safety were key outcomes.

In addition to the inshore dolphin field-based activities, the project team continued the work strengthening the existing network and communicating project progress to a variety of relevant stakeholders including Indigenous and non-Indigenous, scientific and non-scientific audiences. Of particular note is the co-presentation by Dr Helen Penrose (JCU) and Ms Cheryl Grant (Girringun Aboriginal Corporation) of the project, 'Looking for palangal (dolphins) and balangal (dugongs) in Girringun sea country' at the annual Australian Marine Science Association Conference in July 2013. This communication has opened a pathway for new links, collaborations and shared knowledge between other marine scientists and the traditional custodians of the Girringun sea country region.

Inshore Dolphin Project Scoping Field Trip (October 2012), Gudang land and sea country (Pajinka, Cape York). *Image: Helen Penrose (JCU)*

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

Dr. Glenn De'ath, AIMS

Project Background

Little information is available on the diversity of the GBR, or the mechanisms responsible for patterns of biodiversity. This project maps the diversity of biota and environments of the GBR in order to relate biotic diversity to spatial, environmental and temporal drivers. The project uses existing long-term and large-scale data from the GBR, including the Long Term Monitoring Program on coral cover, data on density of Crown of Thorns Starfish and seafloor diversity, large-scale diversity surveys of corals, water quality and coral bleaching history, satellite derived sea surface temperature and ocean colour history data, and tropical cyclone path and intensity information. The purpose of this research is to inform the Outlook Report and to guide prioritization of spatial management in a changing climate.

Project Progress

The theoretical and technical developments of diversity theory, based on the multinomial model, have been completed. The theory has been published, and software to apply to the theory to data analysis of environmental and ecological data has been published and is freely available in the online R package "Multinomial Diversity Models".

These developments provide the necessary tools and knowledge to address two of the four new management goals of GBRMPA, namely "protecting and restoring the Reef's ecosystem health and biodiversity", and "reducing cumulative impacts". Furthermore, the Strategic Assessment states GBRMPAs first principle for managing environmental impacts is that the "conservation of biodiversity and ecological integrity should be

A giant trevally ready for external tagging after transmitter implantation. *Image: Mario Espinoza*

the fundamental consideration in decision making". These "goals" and "principles" will require substantial information on spatial and temporal patterns of the Reef's biodiversity, information that is currently insufficient (spatial patterns at the whole-of-reef to subregional scales) or non-existent (temporal patterns).

Having shown a >50% loss in coral cover over the past 27 years, many questions remain unanswered. For example, how has diversity changed over that period? If few taxa have been lost, then recovery may be more rapid (under good conditions) than if we had lost many taxa from large areas of the GBR. For the latter case, recovery of the Reef may take much longer, or remain incomplete.

Preliminary new analyses of the benthos and fish LTMP data suggest that total diversity of the GBR has not declined over time to the extent that coral cover has declined, however there is strong turnover of species. The project team is currently investigating the effects of storms, COTS and cyclones on diversity to assess the resilience of coral and fish communities. Links between changes in these two communities are also being explored.

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

Dr. Michelle Heupel, AIMS & JCU

Project Background

The mobility of many predatory fish complicates the management of these species, especially in regions such as the GBR, where there is a complex mosaic of areas open and closed to fishing. Understanding the residency and movements of large predators is consequently important to ensuring the long-term sustainability of this functional group. This project defines the extent of movement of mobile predator species in coastal and reef ecosystems. The purpose of this research is to guide spatial management of the marine park and fishery management.

Project Progress

An array of 14 species of marine predator have been monitored at reefs offshore from Townsville to determine their presence and movement patterns in relation to marine park zoning. As expected, movement patterns differ between species indicating variable benefits from marine park protection.

Teleost predators tend to use a single reef indicating whole of reef scale zoning will have benefits to these populations. However, species such as Spanish mackerel, and possibly giant trevally, travel between reefs and thus zones. Reef sharks also showed variable patterns of movement. Grey reef sharks and silvertip sharks show two separate patterns within the individuals tagged. Some individuals remain resident at a single reef while others move broadly among reefs and zones. In contrast, bull sharks were never observed to remain at a single reef with all tagged individuals moving broadly along the coast between reefs and inshore habitats, and as far south as Moreton Bay. Complementary data from the Capricorn-Bunker group of reefs indicates different movement patterns may be present in sharks in this region. This suggests regional or reef based differences in movement may be occurring.

The high degree of variability in how marine predator species use reef ecosystems indicates that marine protected areas will not provide a single solution for the management of these populations. Complementary management measures such as catch restrictions will need to be employed in conjunction with marine park zones to ensure sustainability of these species within the GBR.

Researchers tag a blacktip shark in Bowling Green Bay. *Image: Peter Yates*

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

Prof. Colin Simpfendorfer, JCU

Project Background

Sharks play an important role in marine ecosystems but are facing increasing pressure from fishing and other anthropogenic factors. Inshore waters of the GBR play an important role as nursery areas for sharks. However, the same inshore waters are also most prone to fisheries exploitation and effects of freshwater discharge from coastal streams and rivers. This project examines the importance of different types of inshore habitat (protected bay vs open coastline) and marine park zoning (open and closed to fishing), and how environmental factors such as freshwater discharge from rivers effect how these nursery areas function. The purpose of this research is to inform future marine park zoning and fisheries management.

Project Progress

Surveys of sharks in five bays along the central GBR coast have revealed a wide array of shark species (at least 22 species) utilise the region. Many of these use nearshore waters as nursery areas, where the young live for a period after birth. Recently collected data has shown that the species composition of these individual bays varies quite markedly. Analysis is currently underway to identify the drivers of these differences, which may be related to available habitats, marine park zoning or environmental factors.

The surveys have also identified that despite being used as nursery areas, there are some species that use these bays as adults much more than would have been predicted based on previous data. These data suggest that current paradigms of shark use of nearshore areas may need to be re-examined, possibly in a size based context rather than the traditional maturity based context.

Acoustic telemetry data from juvenile sharks in Cleveland Bay has demonstrated that there can be clear differences in habitat use of some species related to large-scale environmental factors. For example, there have been substantial differences in the residency and habitat use of sharks following Cyclone Yasi. Shorter term effects have also been detected, with several species showing significant changes in distribution and habitat use due to high levels of freshwater input during the wet season. The results of this work are providing some useful insights into how small sharks respond to changes in their environment.

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

Dr. Brad Congdon, JCU

Project Background

There has been a decline in seabird numbers observed in many breeding colonies. There is a need to understand the movements and habitat use of pelagic environments by foraging seabirds to seek an oceanographic explanation for the decline. This project identifies and maps foraging grounds for boobies and shearwaters; overlays satellite derived information on biophysical oceanographic characteristics; quantifies prey availability; and establishes linkages between areas, population processes, anthropogenic activity, and environmental effects including climate change. The purpose of this research is to guide management of seabirds, including implications for the management of offshore islands and fisheries.

Project Progress

Core foraging areas for GBR breeding shearwaters have been identified and mapped at three spatial scales across multiple years. On-going analyses confirm previous preliminary findings.

During breeding adults use only near-colony foraging grounds (<200km) for chick provisioning. Foraging activity at these sites appears linked to both local oceanic upwelling and also river flood-plume dynamics. Adults on longer self-provisioning trips routinely travel up to 1000km and forage in association with the Tasmantid Seamounts of the Coral and northern Tasman Seas. At-distance foraging sites are characterized by steep bathymetric change and associated large-scale eddies and frontal systems. Foraging activity at these sites overlaps significantly with known commercial fishing activity. Most at-distance sites are outside the management zone of the GBRMP. Both near-colony and at-distance foraging locations vary among years, but individuals may consistently reuse specific locations both within and between-seasons.

When not breeding GBR shearwaters are trans-

equatorial migrants that overwinter in Micronesia. To reach overwintering sites individuals travel >6000km at speeds of ~430km/day. There is a high degree of overlap in winter foraging locations among individuals within a ~15002kms area. Much of this region encompasses the Western Pacific Warm Pool; a wintering region used by other tube-nosed seabirds that breed in Japan. Importantly, both shearwater migration routes and over-winter grounds overlap significantly with areas used by the world's largest tuna fishery, the Western and Central Pacific Tuna Fishery, which provides some of the highest commercial catch rates globally. This finding raises significant previously undocumented conservation concerns for this GBR breeding seabird species. There are clear international implications for conservation management of these species.

Project 8.1: Monitoring the Ecological Effects of the GBR Zoning Plan on Mid and Outer Shelf Reefs

Dr. Hugh Sweatman, AIMS

Project Background

There is a need to test the effectiveness of spatial management arrangement on the GBR. This project tracks a suite of biodiversity indicators across 26 closely matched pairs of reefs offering fished and unfished contrasts. The 52 reefs are spread through the mid shelf from Cairns to Gladstone, which covers the highest incidence of Crown of Thorns Starfish outbreaks. The purpose of the research is to determine whether fishing has any impact on the frequency and/or severity of these outbreaks and to provide input to the Outlook Report.

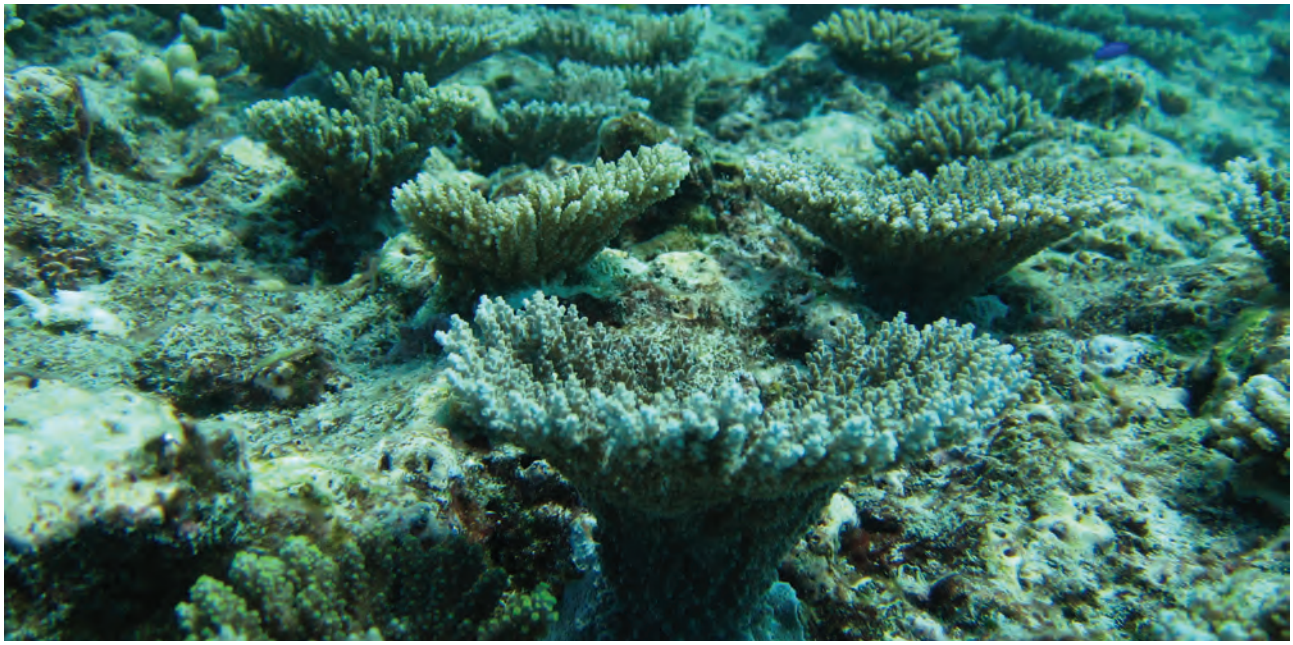
Project Progress

The first cruise surveyed eight reefs in the Capricorn-Bunker Group at the extreme south of the GBR plus four reefs in the Swains sector to the immediate north. The Capricorn-Bunker reefs were damaged by sub-cyclonic storms in 2008 and by Cyclone Hamish in 2009.

The coral communities on Capricorn-Bunker reefs are dominated by tabulate *Acropora* spp and had not suffered a major disturbance for more than a decade so coral cover was high. These corals are vulnerable to storm damage when colonies grow large, so the coral cover dropped by more than half due to the storms. In many areas the surface of the underlying reef is relatively devoid of structure so provides little cover if the corals are removed. Because of this, reef fish numbers also declined sharply. However, the recent surveys found continuing evidence of coral recovery. It is too soon to assess if the rate of recovery differs depending on whether or not the reefs are open to fishing, as has been suggested for some Caribbean reefs.

Reefs that are towards the seaward margin of the Swains Reef complex were east of the track of Cyclone Hamish and were less severely damaged. Coral cover on these reefs has increased rapidly in the period without major disturbances and is now high. This clearly shows that many mid-shelf and offshore reef communities of the GBR retain the capacity to recover if the intervals between major disturbances are sufficiently long.

Crown-of-thorns starfish have consistently been recorded in low numbers of large individuals at some reefs in the Capricorn-Bunker sector in the past, but in recent years, densities at Lady Musgrave Island Reef have reached 'Incipient Outbreak' levels, and Fairfax Island Reef has 'Active Outbreak' densities. Low numbers were also seen at Boult Reef. Only three reefs in the Swains sector were surveyed and a single starfish was seen in manta tow surveys at Chinaman Reef.



Many reefs in the Capricorn – Bunker group at the southern end of the GBR were badly damaged by storms and cyclones in 2008-2009. The shallow coral communities on these reefs are dominated by tabulate *Acropora* spp. whose growth form makes them susceptible to wave action. This picture shows a high density of small colonies that will grow quickly in the absence of further disturbances. *Image: AIMS LTMP*

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

Prof. Garry Russ & Dr. David Williamson, JCU

Project Background

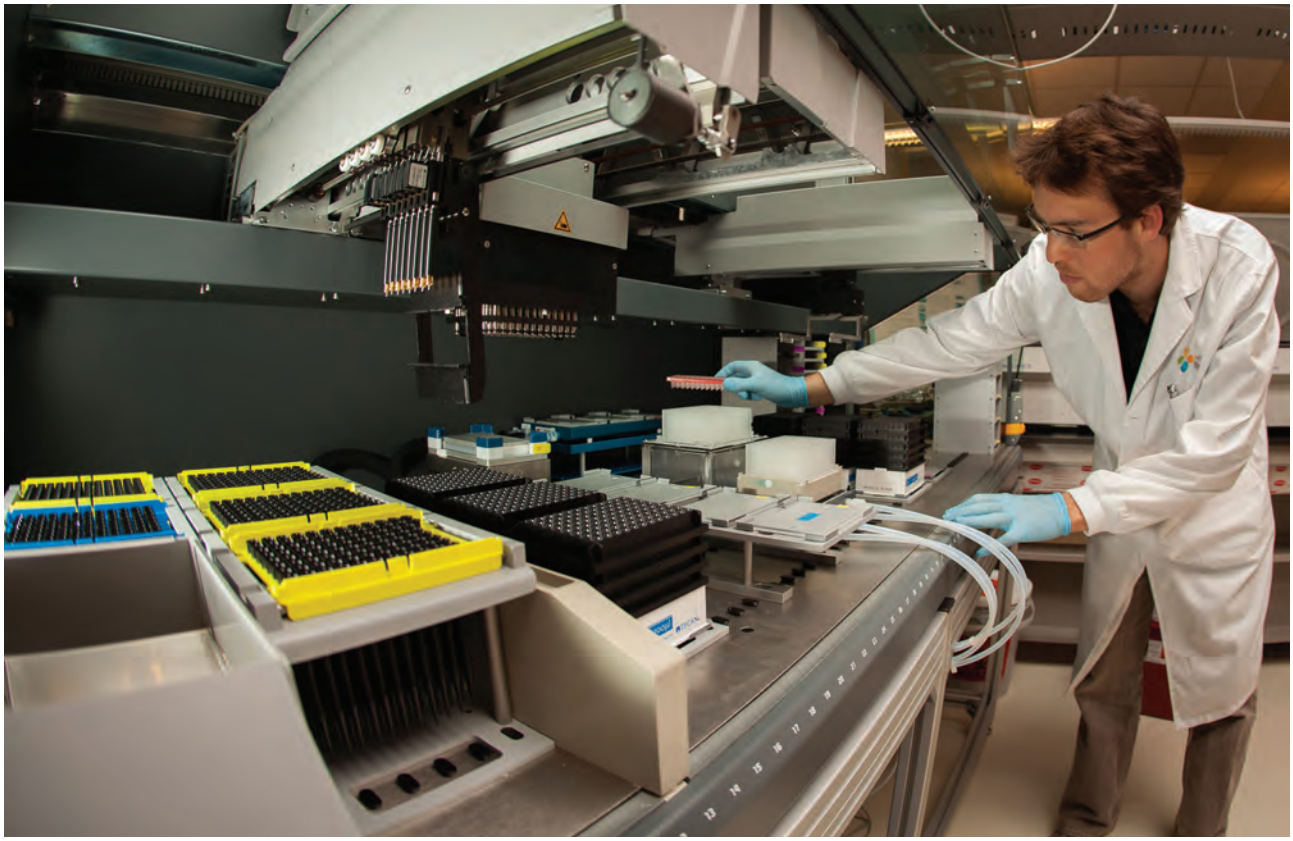
There is a need to objectively assess the ecological and sociological implications of spatial management on the GBR. This includes determining how and to what extent no-take reserve networks may help to protect biodiversity, sustain stocks of fished species and increase ecosystem resilience. This project compares the abundance of fish, corals and the incidence of coral disease between fringing reefs that have been closed to fishing at different times in the past with adjacent areas that remain in use by the recreational fishing sector. The purpose of this research is to guide marine park management in the future, including zoning and compliance.

Project Progress

In May 2013, following exposure to two distinct flood plume events in both early 2011 and early 2013, the overall mean percent cover of live hard coral on fringing reefs of the Keppel Islands was 13.2%, representing a dramatic decline of 66% from 2011. Despite some variability in preceding years, there was no significant difference in the 2013 mean percent cover of hard coral on reefs within long-term no-take reserves (NTRs) (since 1987), RAP NTRs (since 2004) and fished zones. The flood plumes have caused significant changes to the composition of benthic and fish communities. The majority of the fringing reefs in the Keppel Islands are currently degraded, with low diversity benthic and fish assemblages, reduced numbers of key fish species and generally low productivity.

NTRs of the Keppel Islands partially mitigated against declines in coral trout populations following the 2011 flood disturbance. The highest abundances of coral trout remained in the sites within NTRs that escaped the worst effects of the flood plume disturbance, and retained hard coral cover and habitat complexity. Between 2011 and 2013, coral trout declined by 60% across all sites. The overall magnitude of the reserve effects were maintained until 2011, with mean coral trout density ratios of 1.5:1 between old NTRs and fished zones, and 3.4:1 between new NTRs and fished zones, but these differences were eroded in response to the 2013 flood plume.

The high frequency and severity of extreme weather events in recent years has heavily impacted the condition of a swathe of coral reefs in the GBRMP. The Keppel Islands is one location in which the degradation of reefs has been particularly severe. Like other inshore reefs of the GBRMP, it serves as a vital reference area for assessing the impacts of disturbance events on coral and fish assemblages, and the role of management measures (e.g. zoning) in enhancing population persistence, fishery sustainability and long-term ecosystem resilience.



Hugo Harrison (JCU) analysing coral trout (Plectropomus spp.) tissue samples from the GBR Marine Park in the genetics laboratory at King Abdullah University of Science & Technology (KAUST) in Saudi Arabia. *Image: Tane Sinclair-Taylor (KAUST)*

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

Prof. Geoff Jones, JCU

Project Background

Previous research has shown compelling evidence for no-take reserves as an effective conservation and fisheries management tool. However, the scale over which reserves benefit fisheries by replenishing stock and the degree to which they contribute to maintaining fish populations in the long term needs to be evaluated. This project applies genetic parentage analysis and biophysical modelling to assess the role of marine reserve networks for coral trout conservation and fisheries on a regional scale. The purpose of this research is to guide marine park management in the future, including zoning and the conservation of fish diversity.

Project Progress

Genetic databases have been compiled for 4,334 *Plectropomus leopardus* and *P. maculatus* from three regions - the Keppel Islands, Capricorn Bunkers and Percy islands. They have been genotyped and scored at 25 hyper-variable microsatellite markers for population and individual-based genetic analyses. These markers provide species-specific genetic profiles to confidently discriminate between *P. leopardus* and *P. maculatus*, and identify inter-species hybrids in each region. Preliminary population-level analyses show strong genetic differences between the Capricorn Bunkers, Keppels Islands and Percy Island for *P. leopardus*, but not for *P. maculatus* suggesting different patterns of connectivity between species. It suggests that *P. leopardus* from the three regions are discrete genetic stocks.

The biophysical model has provided testable predictions of levels of self-recruitment and connectivity among the three regions, using four different behavioural scenarios, from completely passive dispersal to highly directional swimming. The passive dispersal predicts a much higher level of self-recruitment within regions, compared with the active swimming model. In addition, the model predicts bi-directional connectivity between some regions and not others. The different model predictions will be fully tested with genetic parentage analysis.

The project team is developing a spatially explicit metapopulation model to examine effects of marine reserves, fishing pressure and habitat damage on coral trout dynamics. A preliminary negative exponential dispersal kernel has been calculated for *P. maculatus*, based on previous parentage studies and recruitment habitat data. It predicts that the effective larval dispersal distance is <50km. This will be fully tested with the new round of parentage studies.

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

Dr. Ken Anthony, AIMS

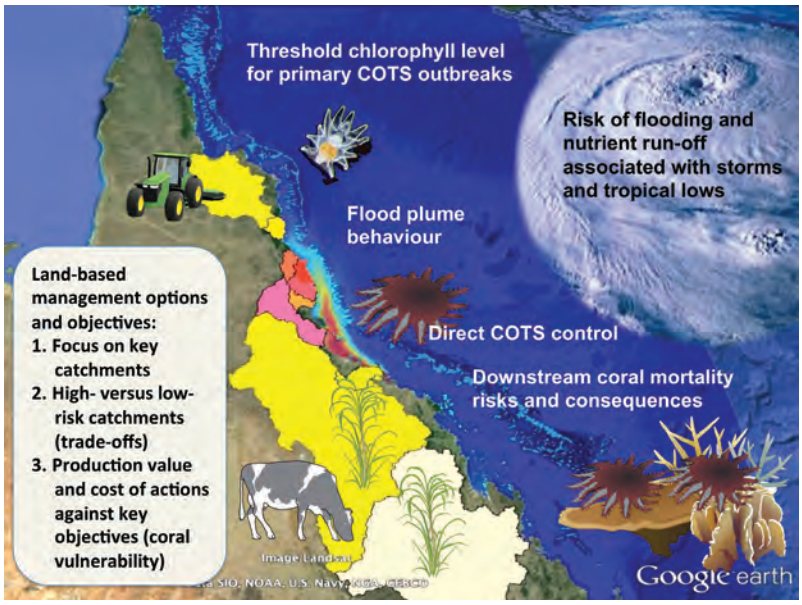
Project Background

Understanding spatial and temporal patterns of vulnerability under environmental impacts and change is central to the management of marine parks. Quantitative assessments of vulnerability, however, are one of the greatest challenges for management planning of coral reef ecosystems, including the GBR. This project creates vulnerability maps for coral reef communities and allows managers to prioritise the conservation of subregions with high natural resilience to disturbance factors, including elevated sea surface temperatures, declining water quality, cyclones and Crown of Thorns Starfish. The purpose of this research is to assist land use planning in coastal catchments and marine park management.

Project Progress

Future cyclone risks to coral mortality are now modelled using a combination of historical spatial clustering and cyclone genesis models to reconcile different schools of thought in the climate science community (MIT, CSIRO, BOM). Our cyclone projections are informed by a suite of global circulation models, but anchored statistically in the historical cyclone patterns on the GBR.

Water quality modelling is now using eReef hydrodynamic modelling coupled with observed plume behaviour to simulate the distribution of chlorophyll concentrations triggering COTS primary outbreaks, and also predicting water quality stress on corals. The nutrient and sediment in receiving waters are formally linked to modelled run-off and tied to land-use practices.



Landscape approach to the complex problem of coral reef vulnerability and multiple conflicting objectives. The example illustrates a subset of the problem focusing on the links between land-use, water quality and the risk from COTS infestations. Here, coral vulnerability for the GBR at large and by section is assessed against land production values and costs associated with different management alternatives. *Image: Ken Anthony (AIMS) and Eve McDonald-Madden (UQ)*

Separate modelling studies of Crown of Thorns Starfish connectivity provide stronger links between land-use management options, direct COTS intervention and spatial and temporal projections of coral vulnerability. This work is currently being used by GBRMPA to help focus AMPTO efforts on the Reef.

Integration of GBR coral vulnerability model with decision analyses is well underway. The team has made significant progress here and has produced a comprehensive decision-support framework interlinked with the vulnerability analyses. This framework now enables the project team and research users, for the first time, to address questions of how different environmental scenarios (with local, regional and global drivers) affect GBR coral resilience vulnerability in space and time, in essence dynamic resilience and vulnerability maps. The spatial texture in resilience and vulnerability is critical to guide spatial planning, the prioritisation of management efforts and the consideration of effective and cost-efficient actions given limited resources.

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

Dr. Cathy Dichmont, CSIRO

Project Background

Management Strategy Evaluation is a decision support tool to assist managers. It is an approach to informing stakeholders of the likely consequences, costs and benefits of choosing particular management decisions. This project develops methodology to allow GBR managers to evaluate alternative management scenarios and choose between options. The project focuses on tools to assist in the management of the inshore region for biodiversity outcomes, particularly inshore multispecies fisheries management, using a stakeholder driven approach. The purpose of this research is to provide a template for the localised management of inshore resources in the Great Barrier Reef Marine Park.

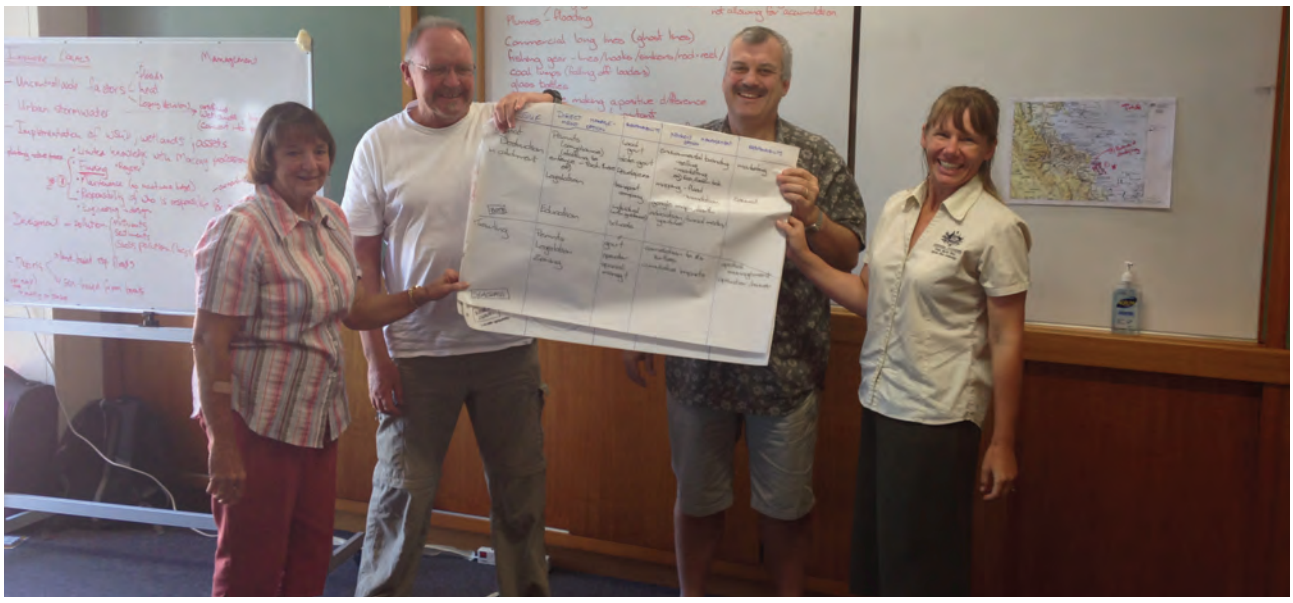
Project Progress

Two case studies have used the adaptive management process to address coastal biodiversity management options in a local area using local stakeholders. The project started with getting to know how the system works through the elicitation of qualitative models of key assets in the region, followed by developing objectives, before developing management options.

In Mackay, these steps have been undertaken with scientific input from experts at each stage and a local community group based on an expanded membership of the Local Marine Advisory Committee. This group have met almost every six weeks in the last year so their time commitment has been enormous. In return, the experts have always kept all their presentations Mackay-specific, which seems to have been key to their successful reception.

The survey undertaken in Mackay to get public input to the objective weighting highlighted that the rigorous, but more trying Analytical Hierarchical Process – a well known decision analysis method – is not well received by the public. A modification of the Point Allocation method – known for having repeatability issues when one has many objectives (as is the case here) – was modified to a Hierarchical Point Allocation system, which has worked extremely well. Almost no changes to the Analytical Hierarchical Process analysis method is needed, but the consistency test is more intuitive.

In contrast, elicitation in the Burdekin region has been difficult due to legacy issues prior to this project commencing. Locals would not commit to a group and interactions have been individual. This has meant many struggled to see the value of the process. Only the objectives review and qualitative model will now be delivered for the Burdekin region, but the scope is expanded to include Bowen.



Project team members and members of the reference group describe their management solutions for inshore corals. *Image: CSIRO*

Project 9.3: Prioritising management actions for Great Barrier Reef islands

Prof. Bob Pressey, JCU

Project Background

Management of conservation on the 900 islands of the GBR is a complex, dynamic and multifaceted challenge and there is a need to prioritise the use of limited management resources. This project develops an explicit decision-making framework for cost effective management actions across the GBR islands. It maximises a conservation outcome defined by specific objectives for diverse natural features, including native plant and animal species, vegetation assemblages and breeding aggregations in the face of a range of threats including the uncertain prospects of climate change. The purpose of this research is to assist GBRMPA and the Queensland Government with management of GBR islands.

Nesting Noddy Tern on North West Island. *Image: John Hicks*

Project Progress

Through regular discussions within the project team and with outside experts, the key variables to be used in the decision making tool were identified. The number of variables was also reduced to make the project realistic and manageable. In addition, both features and threats have been put into groups when possible. For example, birds that nest in the ground and are subject to the same threats have all been placed into one category. This allows for widespread applicability to other islands.

In order to begin eliciting information from experts, and to develop the model, the project is focusing on an initial subset of 13 islands. These islands were chosen based on the judgement of the managers involved in the project. These islands represent a wide range of size, regional ecosystems, species presence, and use.

The short-term aim is to systematically collect information from databases and expert opinion on features, threats, the effectiveness of actions in reducing threats, and the cost of management actions.

The dataset has been populated with the current information available to the project. We have identified key sources that we need to acquire in order to fill in the table. Additionally, the features and threats lists continue to be refined as we clarify what the ultimate management goals are, and the strategies required to manage both the features and the threats to the islands.

The fine-tuning of these aspects of the project has identified key knowledge gaps, which will be filled with data from expert elicitation, as well as criteria and guidelines to establish when eliciting information. To help with structuring the expert elicitation workshops, guidance has been sought from colleagues at University of Melbourne. In the medium term, the small subset of islands will be enlarged to 100-200.

Project 10.1: Social and economic long-term monitoring programme

Dr. Nadine Marshall, CSIRO

Project Background

Understanding social and economic drivers in GBR industries and communities is critical in forecasting trends and providing the human dimension to scenario planning by coastal managers. This project engages with stakeholders in the GBR region to design and implement the initial stages of a long-term social and economic monitoring program featuring local and regional communities, traditional owners, marine tourism, commercial and recreational fishing, catchment industries, ports and shipping. Long-term social and economic monitoring program will augment existing long-term biophysical monitoring of the GBR and increase the effectiveness of its management. The purpose of the research is to provide information for coastal planners and managers, including the GBRMPA.

Project Progress

The project team modified a well-established framework for assessing ecosystem state (the Millennium Ecosystem Assessment), towards assessing the human dimension of ecosystems. In combination with industry, government and community, the framework was used to design and help implement the Social and Economic Long Term Monitoring Programme for the GBR region. The project team has mapped, measured and monitored the activities and dependencies of people on the GBR, human well-being and important drivers for the region such as perceptions, values, behaviours, markets, media, demography, technology, etc. During this reporting period, the team surveyed more than 8,000 people.

Online responses from 2,002 Australians highlight that the GBR is Australia's most inspiring landmark and significantly

contributes to the identity of the nation. Results also confirm that Australians are worried about the future of the GBR and its management, especially impacts from climate change.

Face-to-face interviews with 3,151 local residents highlight the central role of the GBR in the identity and lifestyle of local people. The project found, for example, that nearly a quarter of residents own a motorboat, and another 26% are dependent on the GBR for at least some of their household income.

Face-to-face interviews with 2,621 tourists from 56 countries featured the level of attachment that tourists have with the GBR; tourists love its beauty and WHA status.

The team interviewed 119 tourism operators and 224 commercial fishers by phone, and fourteen for a case-study. The data clearly illustrates the personal and financial connection that these people have with the GBR.

Project 10.2: Socio- economic systems and reef resilience

Professor Natalie Stoeckl, JCU

Project Background

The GBR is famous for its spectacular coral, rich biodiversity and natural beauty. However, none of these important assets are bought or sold in the marketplace, so none are explicitly 'valued' with a price. Recognising that absence of price does not mean absence of value, this project improves understanding of these non-market 'values' to a variety of different stakeholders. This project improves understanding of the manner in which GBR ecosystem services are valued, including an intrinsic value for characteristics of the GBR. The purpose of the research is to improve understanding of the relative importance of external socioeconomic pressures, such as commodity prices and exchange rates, to land uses that may impact on the GBR.

Project Progress

Surveyed residents felt that having healthy coral reefs and reef fish, no visible rubbish, iconic marine species, clear ocean water, healthy mangroves and wetlands, were more important to their overall quality of life than the jobs and incomes related to the mining and agricultural, commercial or tourism industries. The 'average' resident was somewhat dissatisfied with the benefits they received from cheap shipping, and from the mining, agriculture and commercial fishing industries.

The items that tourists rated as the most important 'draw-cards' to the region were clarity of water, healthy coral reefs, healthy reef fish and lack of rubbish. High quality accommodation and affordability were important, but less than these other factors.

Going to the beach was the most popular GBRWHA-based activity for both residents and tourists. Fishing and boating were the next most popular activities of residents. Fishing was not popular with tourists; instead going to the islands and off-shore reefs for snorkelling were their second most popular activities.

Both residents and tourists reacted more negatively to the idea of more oil spills, murkier water, more rubbish, or less coral than they did to the thought of a 20% increase in local prices.

Project 13.1: e-Atlas

Dr. Eric Lawrey, AIMS

Project Background

The e-Atlas is a website, mapping system and set of data visualisation tools for presenting research data in an accessible form that promotes greater use of this information. The e-Atlas serves as the primary data and knowledge repository for all NERP Tropical Ecosystems Hub projects. The e-Atlas captures and records research outcomes, making them available to research-users and hosts meta-data records, providing an enduring repository for raw data. It is also developing and hosting web visualisations to allow viewing of information using a simple and intuitive interface. In doing so the e-Atlas is assist scientists with data discovery and allowing environmental managers to access and investigate research data.

Project Progress

In the last six months the e-Atlas team has focused on the development reference datasets and the development of the Torres Strait e-Atlas.

An improved basemap, called the *Bright Earth e-Atlas Basemap* was developed and released. It focuses on Queensland mainland and Great Barrier Reef, highlighting the natural environment and the areas of human influence rather than a traditional roadmap such as Google Maps. This new basemap was requested by and delivered to the BOM eReefs Water Quality Dashboard team and is now the default basemap for the e-Atlas.

In November 2013 a series of workshops was run in the Torres Strait to road-test the progress-so-far on the Torres Strait e-Atlas with representatives from key end-users including the TSRA, AFMA and Tagai College. This workshop provided valuable feedback to the team helping to identify several areas of priority development and problems with server performance under load, which have now been largely resolved.

Prior to the workshop the new Torres Strait e-Atlas was setup including a regionally branded section of the e-Atlas website, a regionally specific mapping portal and a regionally specific metadata search tool. Four general knowledge articles were written and added to the new site covering the topics of seagrass, dugongs, shipping and water quality. In addition to this a new satellite and aerial imagery basemap was developed for the Torres Strait region.

In June 2013 all NERP TE projects submitted spatial information about their project activities to the e-Atlas. These are now available as a series of maps from the e-Atlas site.

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