



National Environmental
Research Program

TROPICAL ECOSYSTEMS *hub*

Great Barrier Reef Water Quality Program Highlights

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.

www.nerptropical.edu.au

Image to the left: RRRC

*Front cover Image: Crown-of-thorns infestation, GBR. The emergence of new infestations after recent floods supports the link between outbreaks of the starfish and water quality.
AIMS Long-term Monitoring Team*

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Programs & Projects

The NERP TE Hub Water Quality Program

In 2012-13, there were eight Water Quality projects within four Programs of the Tropical Ecosystems Hub.

Program 1: Assessing Ecosystem Condition and Trend

Project 1.3: Characterising the cumulative impacts of global, regional and local stressors on the present and past biodiversity of the GBR.

Program 4: Water Quality of the Great Barrier Reef and Torres Strait

Project 4.1: Tracking coastal turbidity over time and demonstrating the effects of river discharge events on regional turbidity in the Great Barrier Reef.

Project 4.2: The chronic effects of pesticides and their persistence in tropical waters.

Project 4.3: Ecological risk assessment of pesticides, nutrients and sediments on water quality and ecosystem health – Phase 1.

Project 4.4: Hazard assessment for water quality threats to Torres Strait marine waters, ecosystems and public health.

Program 5: Cumulative Impacts on Benthic Biodiversity

Project 5.1: Understanding diversity of the Great Barrier Reef: Spatial and temporal dynamics and environmental drivers.

Project 5.2: Experimental and field investigations of combined water quality and climate effects on corals and other reef organisms.

Project 5.3: Vulnerability of seagrass habitats in the Great Barrier Reef to flood plume impacts: light, nutrients and salinity.

Program 9: Managing for resilient tropical systems

Project 9.4: Conservation planning for a changing coastal zone.

Image: RRRC



Dr. Peter Doherty

AIMS Fellow
Science Leader, *NERP Tropical Ecosystem Hub*

Introduction

Healthy marine ecosystems require good water quality. Sediments, nutrients and manufactured chemicals that are now exported from modified catchments, threaten sections of one of the Planet's greatest environmental assets: the World-Heritage listed Great Barrier Reef.

Since 2003, the Australian and Queensland Governments have been committed to halting and reversing the decline of water quality in the GBR Lagoon. Most of the water quality projects in the NERP Tropical Ecosystems Hub have been designed to support this very important public policy initiative.

One of the most tactical (Project 4.3) completed its work in July 2012; just a year from the start of the TE Hub. The outcome (a risk-management framework) has since been implemented with funding from the Queensland Government to inform the investment plan about the relative risks of different pollutants from different catchments. Other projects (1.3, 9.4) will offer longer perspectives on both historical and future human use of the coastal zone. I hope these glimpses will create a desire in readers to learn more about part or all of the NERP Tropical Ecosystem Hub program with details available at www.nerptropical.edu.au.

Image: RRRC

Introduction



Researcher Profiles



**Associate Professor
Jian-xin Zhao**

Principal Research Fellow, Geochemist
Centre for Microscopy and Microanalysis, University of Queensland

Background

In 1998, after more than 20 years in isotope geochemistry and geochronology, Associate Professor Zhao moved into environmental research. His work focuses on palaeoclimate/palaeoenvironmental reconstruction and archaeological/palaeocological studies based on coral reefs at sea and karst cave deposits on land. He developed the mass spectrometry U-series dating methods at the University of Queensland (UQ) and applied them to dating coral reefs in the Great Barrier Reef, Moreton Bay, coastal Western Australia and the South China Sea, as well as important hominid and fauna records in China (e.g. Nanjing Man), Indonesia (e.g. the "Hobbit"), Australia and Polynesia.

Education

Ph.D. (Isotope geochemistry and geochronology), ANU, 1993

Current Research

Associate Professor Zhao's current NERP-based research effort focuses on the use of high-precision U-series dating and geochemical analyses of surface coral rubbles, *Porites* cores, and back-reef and lagoon sediment cores in order to understand the impacts of long-term climate variability and recent European settlement on the biodiversity of inshore reefs in the GBR.



**Professor
John Pandolfi**

Chief Investigator, Palaeoecologist
*ARC Centre of Excellence for Coral Reef Studies,
University of Queensland*

Background

Professor Pandolfi has broad research interests in marine palaeoecology, with emphasis on the effects of anthropogenic impacts and climate change on the recent past history and ecology of modern coral reefs.

Education

Ph.D. (Paleozoic Paleogeography) University of California, Davis, 1987

Current Research

Professor Pandolfi investigates long-term ecological and environmental time-series data over broad spatial scales to discover major past influences of natural variability, human impact, and climate change on coral reef resilience. This research program enables direct linkage among physical variables and biological responses; attempts to tease out the effects of human versus natural variability; provides natural baselines which managers can use to place restoration goals in context; unveils processes that contribute to the resilience of coral reefs over long time frames and changing environmental conditions, and fosters a deep temporal perspective of the role of climate change in coral reef ecology.

Project 1.3: Characterising the cumulative impacts of global, regional and local stressors on the present and past biodiversity of the GBR. *Project Leaders: Associate Professor Jian-xin Zhao and Professor John Pandolfi, UQ*

Project Background

The overarching goal of this project is to establish the relationships between major historical ecological changes in GBR inshore reefs, and major anthropogenic stressors/drivers and climatic events from the past several millennia, through European settlement, up to the present day.

Innovative geochemical, geochronological and palaeoecological methods are being used to investigate the impact of rising sea-level; rising sea-surface temperature; seawater acidification; increased sediment/nutrient discharge; increased pollution from urban development; and other climatic drivers such as ENSO and cyclones on the reef ecosystem. The sampling strategy covers high- and low-impacted regions along the GBR and will allow us to test whether changes in the quality of land-based catchment runoff result in degradation of inshore coral communities.

Project Progress

Coral cores indicate a change in the dominant corals at Pelorus Island (central GBR) between 1930 and 1950, despite relatively benign climate conditions. This scale of change was not evident in core material from the previous 1,500 years, despite large amplitude climate variability and frequent 'super-cyclones', both not seen since European settlement. This suggests that the fast growing branching corals (*Acropora spp.*) may be most sensitive to the changes in coastal water quality (e.g. increased erosion) caused by changing land use.

Coral growth was also measured using 42 cores collected from massive *Porites* heads along a transect extending from just off the Townsville coast out to the central GBR. Results indicate a distinctive cross-shelf pattern in the coral-growth response over the last 50 years with inshore reefs showing a long-term decrease in coral calcification rates, probably due to increased terrestrial run-off and higher sea-surface temperature variability. Cores also show the effects of the major coral bleaching event that occurred in 1998. Preliminary U/Th (Uranium/Thorium) dating of 12 coral fragments from the

Keppel Islands shows that these reef cores cover a period of up to 6,000 years; providing an invaluable record of coral reef development for this region. Other cores from this area have been dated between 323 BC and 2008 AD and show clusters of mortality events, possibly corresponding to cyclones and/or flood events. The timing of these mortality events will be compared with sea surface temperature, river discharge and observational records (among others) to better determine the likely causes.

Finally, cores taken from Hervey Bay show that 40% of the area's coral was lost as a result of the 2011 flood. The effect was highly variable (0-89% loss) and was particularly evident in the path of the flood plume.



Map of Queensland and the Great Barrier Reef showing study locations and the type of sampling being conducted under NERP Project 1.3. *Image: Markham, UQ*

Researcher Profile



Dr. Katharina Fabricius

Principal Research Scientist, Coral Reef Ecologist
Australian Institute of Marine Science (AIMS)

Background

Dr. Fabricius has worked as a coral reef ecologist since 1988, with most of her research directed at better understanding the roles of disturbances (especially ocean acidification, climate change and terrestrial run-off) on ecological processes in coral reefs, and their consequences. In this context, Dr. Fabricius has worked across a very broad range of scientific questions and organism groups, including corals, octocorals, crown-of-thorns starfish, coralline algae, sedimentation, marine snow, organic enrichment, water clarity, storms, bleaching, zooxanthellae, thermal tolerance, biodiversity, bioindicators, calcification, and the interactive effects of multiple stressors.

Education

Ph.D. (Nutrition and community regulation in tropical, reef-inhabiting soft corals) University of Munich, Germany, 1995

Current Research Activities

Dr. Fabricius presently leads a study investigating how long-term exposure to CO₂ alters coral reef communities. Her project team use shallow and cool volcanic CO₂ seeps in Papua New Guinea as a natural laboratory to investigate long-term adaptation and acclimatisation of coral reef organisms and ecosystems to ocean acidification and stress from climate change. Dr. Fabricius is also involved in three projects to investigate cumulative impacts of climate and water quality changes on reef diversity, funded through the Australian Government's National Environmental Research Program (NERP).

Project 4.1: Tracking coastal turbidity over time and demonstrating the effects of river discharge events on regional turbidity in the Great Barrier Reef. *Project Leader: Dr. Katharina Fabricius, AIMS*

Project Background

Turbidity is a measure of water clarity that quantifies small suspended particles, and as such is an important measure of light availability for corals, seagrasses and macroalgae. Turbidity increases may significantly affect marine ecosystems as these particles also carry nutrients, pollutants and diseases. On the GBR such impacts have been related to a five-fold increase in macro-algal cover and a 30% reduction in coral biodiversity on some coastal coral reefs. Changes in turbidity are frequently used in environmental reporting to describe conditions in estuarine and coastal waters.

This project investigates the relationship between changes in land based runoff and clarity of coastal waters for each GBR region in the decade since 2002. Inshore turbidity in four GBR regions is strongly related to river runoff and rainfall, and the distance of a coral reef from a river mouth is a strong predictor of river discharge turbidity at the reef when sediment re-suspension is included in the calculation.

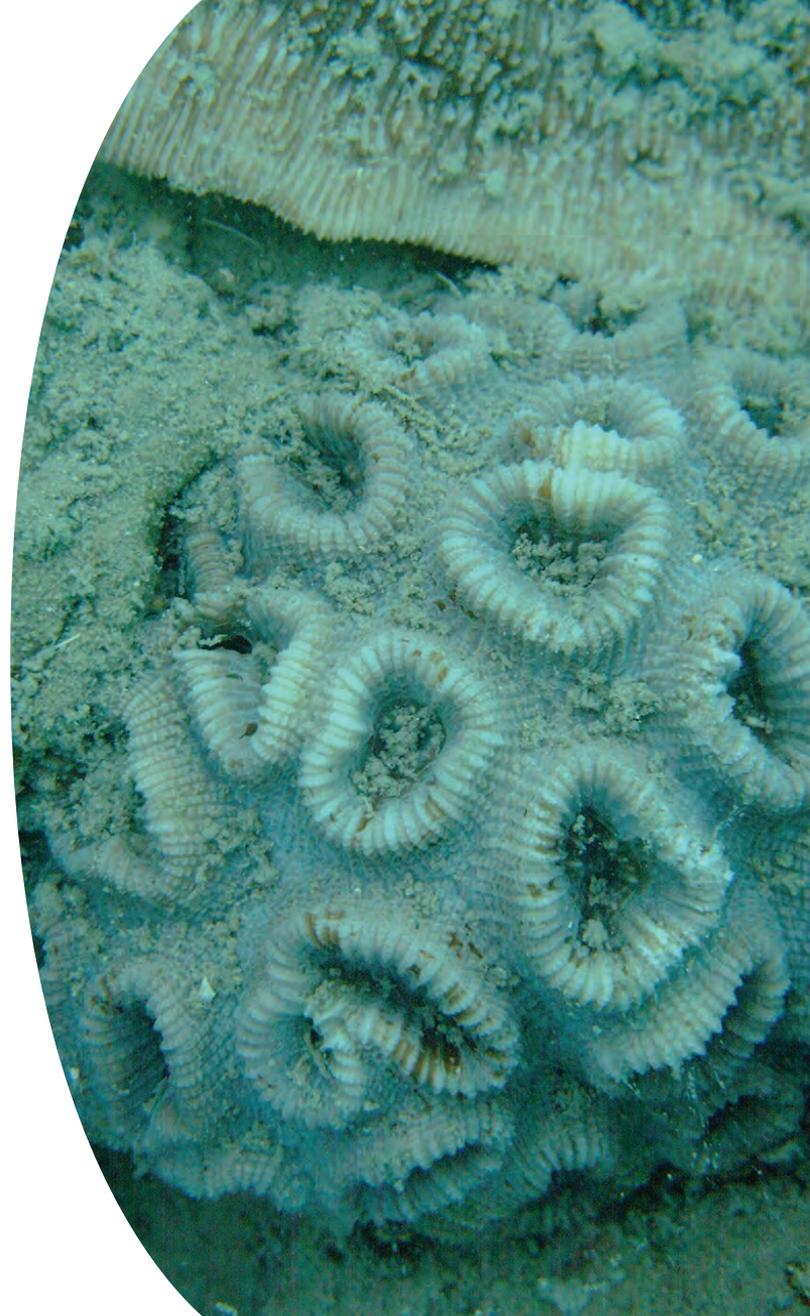
The study will also quantify turbidity differences between wet and dry years. This information can then be used to effectively predict improvements in inshore turbidity associated with improvements in land based runoff.

Project Progress

Given the huge data set available it was decided that the best strategy for Year 1 would be to process the information for the Burdekin region in the Central GBR as a case study and proof of concept. Successful analyses will be extended to other regions during the life of the Project.

Burdekin-related data have been obtained from the Bureau of Meteorology and the Queensland Department of Environment and Resource Management, and prepared for analysis. The data cover the period from January 2001 to October 2012, and include sea level, water and air temperature, barometric pressure and wind direction, gusts and speed as well as river flow and wave height data from Wave Rider Buoys off Townsville, Cairns, Mackay and Rockhampton.

Corals exposed to sedimentation on an inner reef of the Whitsunday Islands. While high sediment loads can be tolerated by a few coral species adapted to live in turbid waters, sediments with high organic content are lethal because they enhance microbial pathogens. *Image: Katharina Fabricius, AIMS*



Researcher Profile



Dr. Andrew Negri

Senior Research Scientist, Water Quality & Ecosystem Health
Australian Institute of Marine Science (AIMS)

Background

Dr. Negri's background and training is in analytical chemistry and toxin research. Since obtaining his Ph.D. in 1993, Dr. Negri has spent 10 years at AIMS and CSIRO studying the chemistry, distribution and accumulation of natural toxins in marine and freshwater ecosystems. In the late 1990s, his research became more coral reef-focussed, including studies on the natural chemistry and microbiology responsible for coral larval settlement. Since 2000, Dr. Negri has been focussing on identifying the toxic thresholds of anthropogenic contaminants on a range of marine species, including corals (all life history stages), sponges and algae. He spent time in 2001 and 2002 identifying contaminants and their effects on marine biota in Antarctica. Recent research focuses on understanding the combined effects of climate change and pollution on tropical marine organisms.

Education

Ph.D. (Chemistry) RMIT University, Australia, 1993

Current Research Activities

Current research focuses on understanding the combined effects of pollution and climate change on tropical marine organisms. Pollutants of interest include pesticides, metals, persistent organic pollutants (POPs), petroleum products and sediments from dredging, while the marine organisms studied include all of the life history stages of coral, micro and macroalgae, sponges and fish.

Project 4.2: The chronic effects of pesticides and their persistence in tropical waters. *Project Leader: Dr. Andrew Negri, AIMS*

Project Background

Pesticides, particularly herbicides from agricultural sources, have been detected all year round in coastal waters of the GBR except in the remote Cape York region. This project aims to identify the herbicide concentrations that cause chronic stress in marine biota and to use that information to refine pollution targets for the GBR. These data will be combined with information on herbicide persistence, water quality and climate to contribute to cumulative risk models, and thus to the development of policy designed to protect the GBR from the cumulative effects of pollution and climate change.

Project Progress

Work is underway to quantify the chronic effects and toxic thresholds of herbicides detected in the GBR on seagrass and corals under a range of climate change scenarios, to determine the persistence of herbicides in tropical waters and to test the toxicity of their breakdown products.

The sensitivity of the seagrasses *Zostera muelleri* and *Halodule uninervis* was tested for four herbicides commonly found in GBR waters. The order of toxicity was Diuron > Hexazinone > Atrazine > Tebuthiuron for both species which is generally consistent with the known impacts of these herbicides on corals and microalgae.

With respect to herbicide persistence, after 100 days the PSII (Photosystem II) herbicides Atrazine, Hexazinone and Tebuthiuron degraded by 15-40% whereas the non-PSII herbicides Metolachlor and 2,4-D degraded by 50-60% and 15-70% respectively. Temperature and the presence of moderate levels of light have little effect on degradation rate and it appears that PSII herbicides may be broken down in part by natural microbial communities in seawater.



Herbicide persistence experiments using flasks in an incubator. *Image: Phil Mercurio*

Researcher Profile



Dr. Rai Kookana

Senior Principal Research Scientist

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Background

Dr. Kookana has had more than 20 year's experience as a research chemist, focusing on the environmental fate of organic contaminants including pesticides, endocrine disrupting chemicals, pharmaceuticals and personal care products. His studies have included: the fate of micropollutants during aquifer storage and recovery of reclaimed water; the role of soil organic matter chemistry on pesticide sorption (i.e. attachment to another substance), mobility and bioavailability, and risk based approaches for minimising off-site impacts of pesticides.

Education

Ph.D. (Soil Science), UWA, Australia, 1989

Current Research Activities

Dr. Kookana leads a research team studying chemistry and ecotoxicology of organic contaminants, and is involved in developing pesticide risk indicators and management practices, and tools and approaches for ecological risk assessment, all with a view to minimising adverse impacts on aquatic and terrestrial environments. He is also studying the environmental fate and behaviour of organic micro-pollutants in reclaimed water and biosolids, and the role of biochar (i.e. charcoal) on sequestration and bioavailability of organic contaminants.

Project 4.3: Ecological risk assessment of pesticides, nutrients and sediments on water quality and ecosystem health – Phase 1.

Project Leaders: Professor Jon Brodie, JCU and Rai Kookana, CSIRO

Project Background

Completed in June 2012, this project developed ecological risk assessment (ERA) tools to guide contaminant impact monitoring, management and alleviation in relation to GBR water quality and ecosystem health. The first phase of the work developed a systematic, objective and transparent ERA methodology that, in the second phase, will allow an ERA to be carried out on nutrients, fine suspended sediments, and pesticides used in agriculture in the GBR region. This methodology included ranking the relative risk of individual contaminants originating from priority catchments to the GBR ecosystems.

Final Outcomes

Following a review of existing methods used in ERA on the GBR, CSIRO developed a five-tiered ERA methodology intended to provide a systematic, objective and transparent approach to measure relative contamination risks faced by the GBR ecosystems due to pesticides, nutrients and sediments.

The tiered ERA method allows rivers draining into the GBR lagoon to be ranked based on the level to which they exceed GBRMPA water quality guidelines, at those marine sites where measurements could be attributed to a particular river (Tiers 1-4), and across the GBR lagoon as a whole (Tier 5).

Tiers 1-4 were designed to deal with progressively higher quality data in terms of exposure to, and effects of, pollutants, and are able to handle any time and location stamped information. Tier 5 requires time series data from many sites, and a technique designed to look back through the data to attribute and characterise risk with respect to individual rivers.

CSIRO's ERA method also includes two sets of loss functions designed to measure the consequences of exposure to pollutants.



Water quality testing. Image: Michelle Devlin

Researcher Profile



Professor Jon Brodie

Senior Principal Research Officer, Water Quality Scientist
TropWATER, James Cook University (JCU)

Background

Prior to taking up the position of Water Quality Scientist at JCU, Professor Brodie spent some years as a lecturer in chemistry at Queensland University of Technology (Brisbane) and at the University of the South Pacific (Suva, Fiji). For the past 30 years, his interests have been in environmental research and consultancy and the management of marine and freshwater pollution in Australia and overseas.

Current research projects include:

Professor Brodie's primary area of research involves water quality issues on the GBR, from the catchment to the GBRWHA itself. Work includes estimation of water composition, pollutant loads and source areas as well as modelling, catchment monitoring and target setting for suspended sediments, nutrients and pesticide loads. He is also involved in projects aimed at understanding the dynamics, distribution and land-use specific composition of river plume waters discharging into the Great Barrier Reef lagoon, and assessment of exposure of GBR ecosystems to terrestrial pollutants. Pollutants are also traced from the catchment to the GBR to help prioritise targeted areas for catchment management initiatives and investigations are underway on best management practices for rangeland grazing and sugarcane cultivation in order to improve water quality management. Finally, his team is assessing best management practices in palm oil plantation development to protect off farm aquatic ecosystems (in PNG).

Project 4.4: Hazard assessment for water quality threats to Torres Strait marine waters, ecosystems and public health.

Project Leader: Professor Jon Brodie, JCU

Project Background

An understanding of water quality status in Torres Strait and its influence on marine foods, human health, marine ecosystems and ecological processes is important for future management. River plumes originating from adjoining areas of Papua New Guinea (PNG) are increasingly influencing water quality in the Torres Strait, particularly as pollutant loads change with increasing catchment development in PNG. Such water quality issues include those associated with regional scale catchment development leading to discharge of heavy metals and other pollutants from the Fly River, particularly in association with mining and land clearing, the port at Daru and planned oil palm plantation development. Associated local scale pollution sources include sewage, storm-water and those related to shipping (eg. dredging, oil spills, ship groundings, shipyards). This project will assess existing and potential sources of water quality pollution in the Torres Strait and design a basic water quality monitoring program to inform pollution management interventions.

Project Progress

A review of existing regional water quality information has been undertaken, and data collated on current status of pollutant sources including sewage treatment plants, waste disposal, shipping, ports and commercial vessels and major developments in adjacent areas. A hydrodynamic model has been constructed to estimate regional water circulation and associated potential dispersal and transport of pollutants in the Torres Strait. Testing has been undertaken on the application of high resolution and high frequency remote sensing data for assessing turbidity and in particular, the potential influence of PNG river plumes in the Torres Strait Region.



On the beach at Masig talking about sewage outfall with island councillor Fraser Nai and John Rainbird (TSRA). *Image: Jane Waterhouse (JCU)*

Researcher Profile



Dr. Glenn De'ath

Principal Research Scientist, Biostatistician, Ecological Modeller
Australian Institute of Marine Science (AIMS)

Background

Dr. De'ath's interests lie in the development of statistical and mathematical models and their application to complex biotic and environmental data. Recent research has documented dramatic declines in coral cover and calcification on the Great Barrier Reef, and has attributed these changes to environmental drivers. Dr. De'ath has been intimately involved with the establishment of water quality guidelines, the regionalisation and rezoning of the GBR, the re-design of the AIMS Long Term Monitoring Program to assess the effects of the rezoning, and the development of the e-Atlas. Dr. De'ath has also developed freely available statistical software, now widely used by many researchers across many disciplines.

Education

Ph.D. (Ecological Statistics), James Cook University, 1999

Current Research Activities

Dr. De'ath is currently involved in research into the effects of climate change, water quality and crown-of-thorns starfish on the Great Barrier Reef, and in modelling the effects of environmental drivers on spatial and temporal change in diversity within ecosystems.

Other work includes development of statistical and ecological models and methods, particularly with regard to multivariate regression trees, principal curves, extended dissimilarity, aggregated boosted trees and multinomial diversity models.

Project 5.1: Understanding diversity of the Great Barrier Reef:
Spatial and temporal dynamics and environmental drivers.
Project Leader: Dr. Glenn De'ath, AIMS

Project Background

We have little information on the diversity of the GBR, or the mechanisms responsible. This project will map the diversity of biota and environments of the GBR, and will relate biotic diversity to spatial, environmental and temporal drivers. The project will be based on 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 octocorals and corals, water quality and coral bleaching history, satellite derived sea surface temperature and ocean colour history data, and tropical cyclone path and intensity information from the Bureau of Meteorology.

Project Progress

A new statistical method has been developed for analysing diversity. The application of this multinomial diversity model (MDM) to studies of diversity should enable researchers and managers to make better informed and consistent judgments about the influence of spatial and temporal drivers on GBR diversity patterns.

Spatial and temporal changes in GBR coral cover were also assessed using three decades of monitoring data collected by AIMS. The analysis showed that coral cover on reefs adjacent to the urban coast of Queensland has declined by half since 1985, while no change was observed on reefs adjacent to the undeveloped coast of Cape York. Causes include cyclones (48% of the effect), crown-of-thorns starfish (42%), and coral bleaching (10%). Coral diseases and other factors (e.g. replenishment impaired by poor water quality) may have also contributed to the observed decline.



Permanent transects on inshore reefs that are surveyed every year to quantify changes of the condition of the coral communities. Close examination of the composition and condition is used for the assessment of impacts of land runoff and other disturbances on inshore reefs of the GBR. *Image: AIMS Water Quality and Ecosystem Health Team*

Researcher Profile



Dr. Sven Uthicke

Research Scientist, Water Quality and Ecosystem Health
Australian Institute of Marine Science (AIMS)

Background

Dr Uthicke has a strong expertise in experimental ecology, molecular ecology, and population genetics. In previous studies, he has investigated genetic connectivity and ecological function of coral reef invertebrates with special focus on echinoderms. His work combines field-based ecological surveys and experimental aquarium studies with “state-of-the-art” laboratory techniques and molecular analyses.

Dr Uthicke is particularly interested in the effects of climate change, especially the warming and acidification of the oceans, on the process of calcification by animals in symbiotic relationships with plants (e.g. corals, foraminifera).

Education

Ph.D. (Biology), University of Hamburg, Germany, 1998

Current Research Activities

For the NERP, Dr Uthicke is applying molecular and ecological research tools to develop more sensitive indicators of changing water quality. This work will concentrate on benthic biofilms, and specifically on foraminifera, diatoms, and bacteria. He will test the hypothesis that managing water quality can ameliorate the impacts of climate change on coral reefs because of interactions among the key physical and chemical drivers of photosynthesis and calcification.

Project 5.2: Experimental and field investigations of combined water quality and climate effects on corals and other reef organisms.

Project Leader: Dr. Sven Uthicke, AIMS

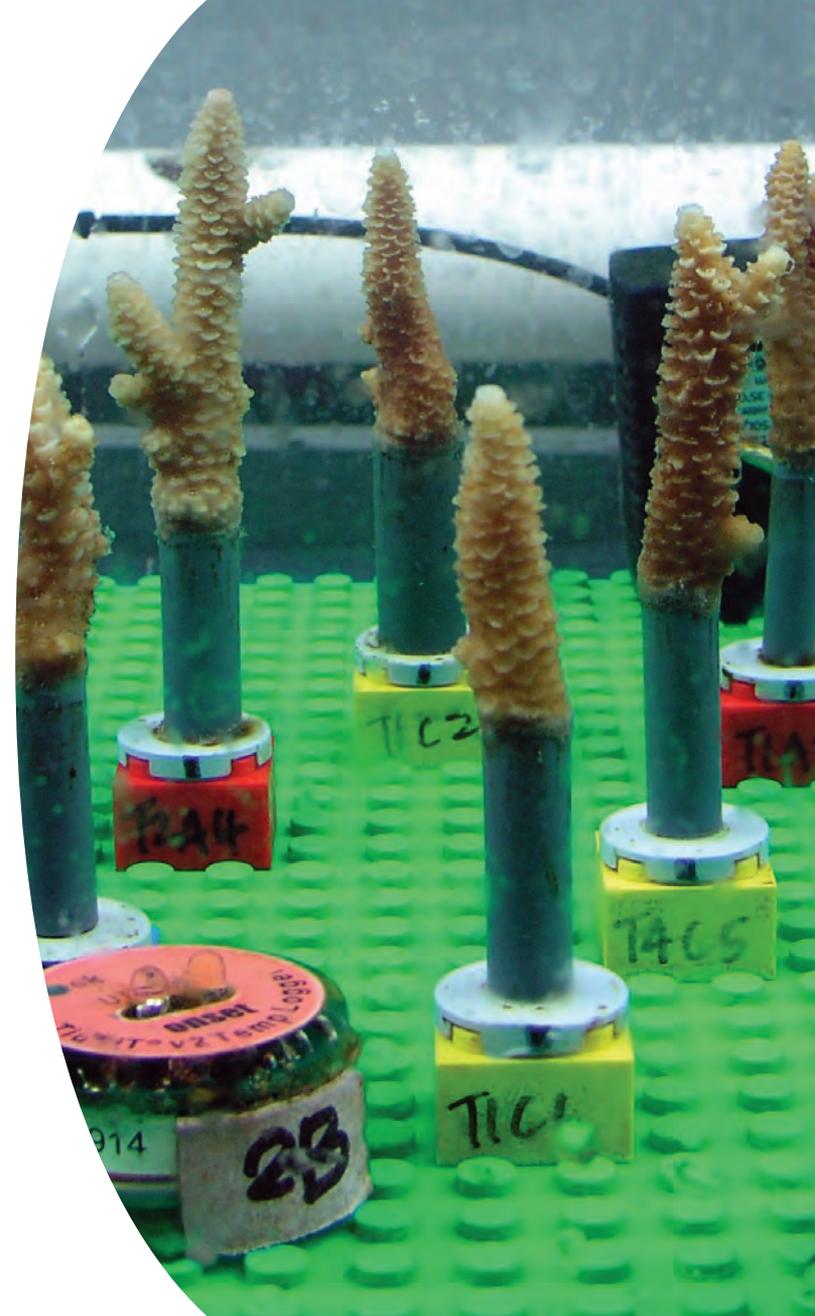
Project Background

Organisms and ecosystems on nearshore reefs of the GBR are particularly vulnerable to increased water temperatures and ocean acidification arising from climate change because of negative interactions with coastal water quality changes (eg. reduced light availability, increased nutrients).

Project Progress

Laboratory experiments have shown that elevated $p\text{CO}_2$ (i.e. a more acid pH) can reduce settlement of coral larvae on crustose algae, an important natural substrate for coral recruitment. Similarly, even a slight increase in $p\text{CO}_2$ can hamper sea urchin reproduction, and influence adult physiology. Experimental work has also revealed that fresher water normally associated with flood plumes actually has a stronger negative effect on coral growth than increased $p\text{CO}_2$.

The situation in the field is inevitably more complex; although increased $p\text{CO}_2$ (i.e. decreased pH) was evident on all 14 near-shore reefs sampled during the recent wet season, associated high temperatures meant that there was no measurable change in the amount of aragonite (CaCO_3) available for calcifying organisms such as corals (called the aragonite saturation state). This indicates that some reefs may be able to buffer the effects of increasing CO_2 . In addition, aragonite saturation state on all inshore reefs was somewhat below that found on mid and outer shelf GBR reefs.



Corals (*Acropora millepora*) in an experiment manipulating CO_2 and salinity. Coral nubbins are mounted on Lego® blocks allowing easy access to the replicates during physiological measurements. *Image: Andrew Negri*

Researcher Profile



Dr. Catherine Collier

Postdoctoral Fellow, Seagrass Ecophysiologicalist
James Cook University (JCU)

Background

Dr. Collier has a background in ecophysiology and marine conservation with work on morphology, physiology, growth and meadow characteristics of seagrasses, and their vulnerability to climate change. Between 2007 and 2010 she was a postdoctoral fellow in the Marine and Tropical Sciences Research Facility, supported by the Commonwealth Environmental Research Program (CERF).

Education

Ph.D. (Marine Botany) Edith Cowan University, Australia, 2006

Current Research Activities

Dr. Collier is broadly interested in coastal marine ecology, with a particular emphasis on seagrass eco-physiology and ecology. Her current work focuses on flood impacts on seagrasses, with the interest triggered by widespread loss of such habitat throughout Queensland and the Great Barrier Reef following record floods in 2011. It is intended that these studies generate information that will improve coastal system management. Dr. Collier's temperate and tropical research experience has heightened her interest in systems comparisons, and her aim is to further our understanding of tropical seagrass ecology and to contribute to the protection of seagrass meadows in regions where livelihoods are particularly dependant on productive natural ecosystems.

Project 5.3: Vulnerability of seagrass habitats in the Great Barrier Reef to flood plume impacts: light, nutrients, salinity.

Project Leader: Dr. Catherine Collier, JCU

Project Background

Seagrass meadows are a vital habitat as they support the biodiversity of estuarine, coastal and reef communities, including fisheries species, and they are a direct food source for obligate seagrass feeders such as dugongs. Seagrass meadows in the coastal zone also form a buffer between the catchment and the reef, trapping sediments and absorbing nutrients, with their high productivity rates facilitating rapid nutrient cycling. Unfortunately, seagrass meadows along the GBR have declined in the majority of areas surveyed, and many sites lack the seed bank that would enable rapid recovery. Most of these sites have either high turbidity (reducing light) and/or extra nutrients (destabilizing the natural balance for these marine plants). Flooding and cyclones have caused further declines in an already fragile system, particularly through flood plume effects. This project investigates the impacts of exposure of seagrass meadows to light, nutrients and salinity for the purpose of predicting thresholds to be used in future risk assessments.

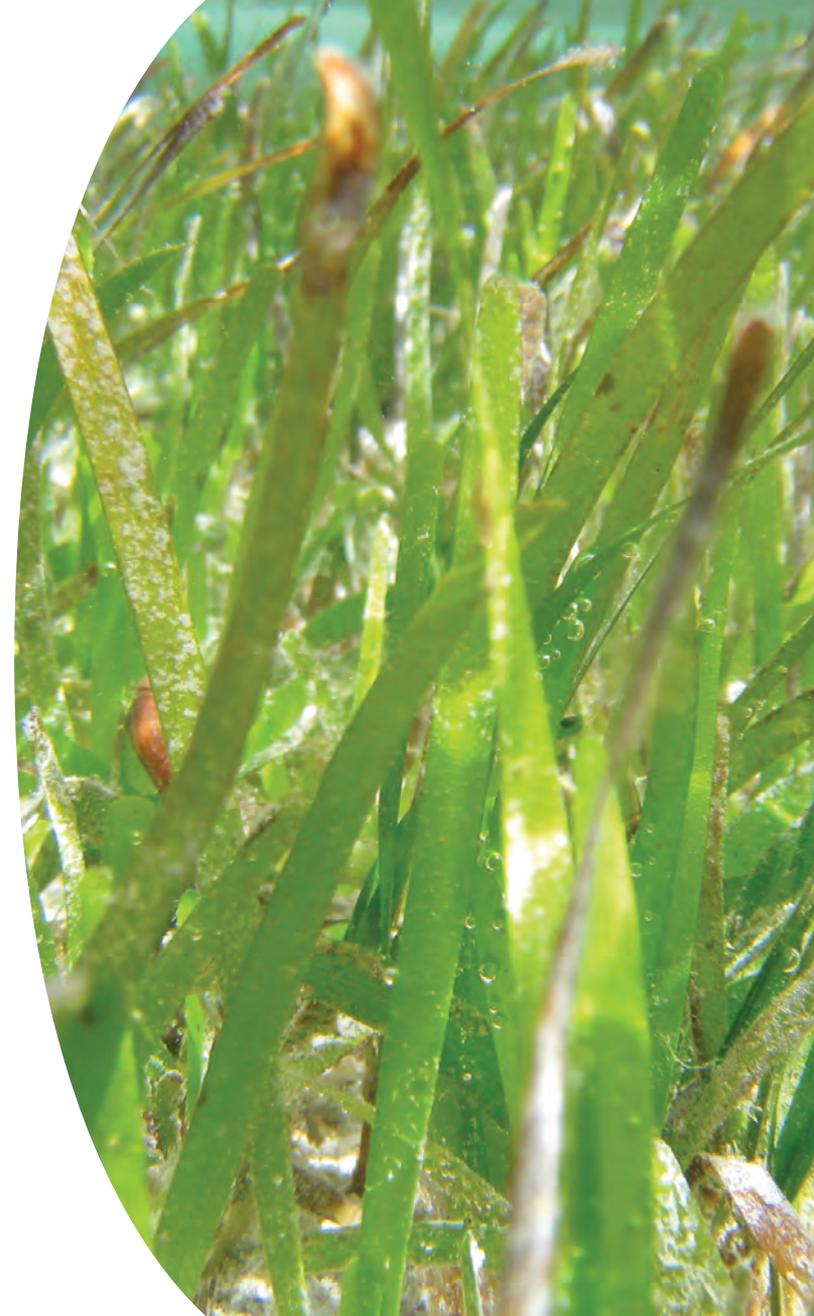
Project Progress

The project aims to deliver an understanding of the extent to which seagrass meadows are impacted by extreme events and changes in water quality in the GBR.

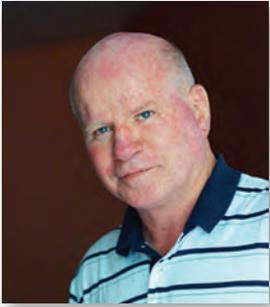
Experiments have been run to determine light thresholds for seagrass growth, and a review of light reduction indicators completed. Tests have also been completed on seagrass responses and threshold tolerances during low salinity events for three dominant seagrass species.

The current plume exposure model has been improved to increase information retrieval from satellite images even if under moderate cloud cover and sun glint conditions, in very turbid areas or those with high total suspended solids (TSS). Mapping of images has also been automated, reducing processing time and human error associated with visual interpretation of plumes. Outputs include evidence of declining seagrass area under high TSS loads.

This seagrass bed has healthy shoot density but some blades already carry the signs of colonising animals that can be deleterious to the plant at high cover. *Image: Catherine Collier*



Researcher Profile



Professor Bob Pressey

Chief Investigator, Ecological Modeller

*ARC Centre of Excellence for Coral Reef Studies,
James Cook University (JCU)*

Background

Professor Pressey is a conservation planner with extensive experience in marine, freshwater and terrestrial environments. His experience includes seven years as a private environmental consultant, working mainly on survey and conservation evaluation of freshwater wetlands and nineteen years as a research scientist with the New South Wales National Parks and Wildlife Service, focused on semi-arid and forest ecosystems. During this time, Professor Pressey contributed to the establishment of the field of systematic conservation planning. Since 2007, he has been Professor and Chief Investigator at James Cook University's ARC Centre of Excellence for Coral Reef Studies, with marine (as well as terrestrial and freshwater) research projects across Australia, through the Asia-Pacific region, and further afield.

Current Research Activities

Professor Pressey is interested in all aspects of conservation planning, including data, modelling, ecology, social sciences, economics, decision-support tools and environmental governance.

Project 9.4: Conservation planning for a changing coastal zone.

Project Leader: Professor Bob Pressey, JCU

Project Background

This project aims to compile spatial data on biodiversity patterns in Great Barrier Reef coastal ecosystems and key biodiversity and connectivity processes and socio-economic characteristics, for direct input to conservation planning analyses and as a basis for modelling dynamics. It will apply scenario-based modelling to develop spatially explicit representations of alternative futures for the coastal zone, using models of climate change, trends in land use, potential changes based on social and economic drivers.

The project will advance world's best-practice in systematic conservation planning, both scientifically and in terms of collaboration with managers and other stakeholders, allowing more informed decisions about the conservation of Queensland's tropical coastal zone and the GBRWHA.

Project Progress

Major events in this reporting period were: 1. A technical working group with many stakeholders focussed on the drivers of change in land use along the GBR coast, and exposed to different approaches to spatially explicit modelling; 2. A second working group, funded by the Australian Centre for Ecological Analysis and Synthesis (ACEAS), attended by stakeholders and scientists representing the Tropical Ecosystems and North Australia Hubs; and 3. A meeting of the Project Reference Group to consider the feedback from these two meetings combining technical experts and consumers for this information.

From these inclusive processes, the main drivers of change in the GBR coastal zone have been defined as: foreign demand for food and mineral resources, governance, community values, advances in science, and tourism. Given these scenarios, the Project Team will model outcomes for biodiversity at landscape and regional levels to inform the planning process about the likely costs and benefits of different land use decisions.

Port and coastal development along the Great Barrier Reef World Heritage Area: NERP Project 9.4 develops scenarios of possible futures to understand impacts of development and design conservation planning tools

Image: Amélie Augé





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