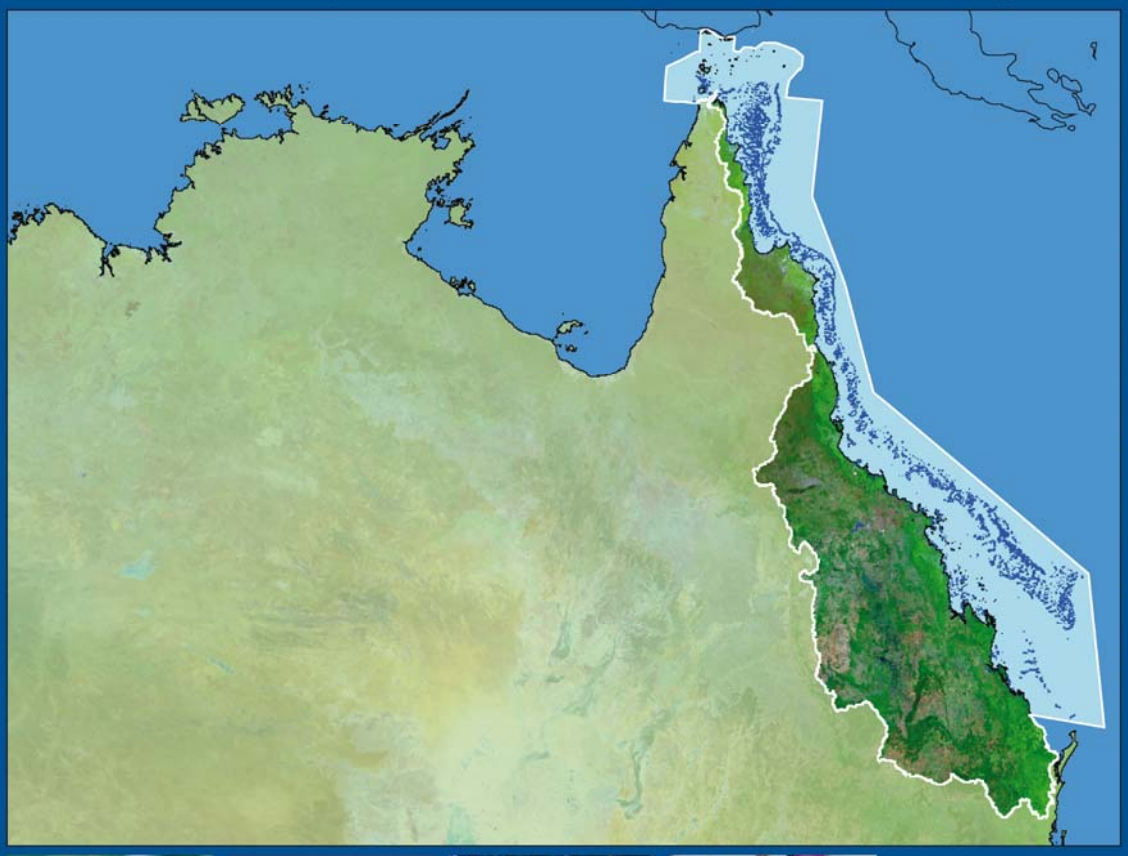
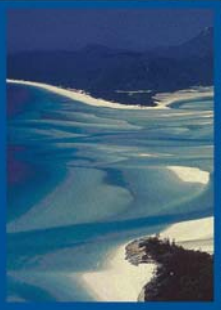
Australian Government

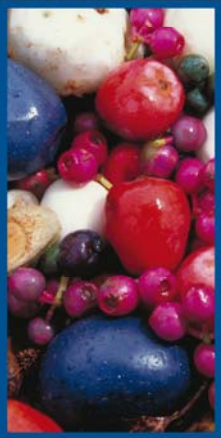
Department of the Environment, Water, Heritage and the Arts

Annual Research Plan 2009-2010

Marine and Tropical Sciences Research Facility







ARP4

Updated
December 2009

PREFACE

It is with much enthusiasm that I introduce the Annual Research Plan for the fourth and final year of the Marine and Tropical Sciences Research Facility (MTSRF). The MTSRF is a $40 million component of the Australian Government's $100 million Commonwealth Environment Research Facilities program. The MTSRF vision is that North Queensland's public environmental assets – particularly the Great Barrier Reef and its catchments, tropical rainforests including the Wet Tropics World Heritage Area, and Torres Strait – maintain or build their health through the generation, transfer and sharing of world-class research and knowledge.

The Australian Government recognises that there are increasing challenges facing our reefs, our rainforests and our fragile coastline. One of the greatest challenges is climate change, with some of the adverse impacts predicted already evident in this area such as the mass bleaching of corals, more severe storm events, ocean acidification and the decline in rainforest biodiversity to name a few. These threats combined with declining water quality and increasing population present a collective challenge to us all.

Through the MTSRF over three hundred of Australia's pre-eminent scientists are working on the issues of climate change, threatened species, declining water quality and sustainable use of the environment.

The program focuses on developing and sustaining partnerships between research institutions, environmental managers and industry. It is through these partnerships that we can collectively benefit from the outcomes of this initiative. This fourth year of the MTSRF program will utilise $7.6 million of Australian Government funding and more than $11 million of cash and in-kind support from leading Australian research institutions.

Research that aspires to influence the management and sustainable use of our environment is a distinguishing factor of the MTSRF's work. Stakeholders and end-users of program outcomes are actively involved in setting the direction of research via their participation in MTSRF Steering Committees.

In 2009/10 I am looking forward to seeing the researchers consolidate their findings and having these results applied by policy makers and other organisations with a role to play in the conservation of our unique environment.

Good environmental policy must be guided by the best scientific knowledge and the MTSRF program is contributing to that knowledge base.

The Hon. Peter Garrett AM MP
Minister for the Environment, Heritage and the Arts
Australian Government

EXECUTIVE SUMMARY

The Marine and Tropical Sciences Research Facility (MTSRF) is a $40 million component of the Australian Government's Commonwealth Environment Research Facilities program, which is managed by the Commonwealth Department of the Environment, Water, Heritage and the Arts. Through a consortium of fifteen research agencies, involving around three hundred scientists, the MTSRF aims to deliver scientific solutions for the problems facing North Queensland's key environmental assets: the Great Barrier Reef and its catchments, tropical rainforests including the Wet Tropics World Heritage Area, and Torres Strait.

In order to achieve its objectives, the MTSRF has planned, funded and coordinated the highest quality, inter-disciplinary research for public good to:

- Ensure the protection, conservation, sustainable use and management of the Great Barrier Reef and its catchments, tropical rainforests including the Wet Tropics World Heritage Area, and Torres Strait.
- Foster an understanding of the interactions of North Queensland's natural environment with the social and economic aspects of North Queensland's communities.
- Support the adoption of science-based knowledge in policies and practices for ecologically sustainable management; and
- Facilitate capacity building for sustainable environmental management research, in partnership with the community, environmental managers, research institutions, and industry and policy makers.

Research funding is guided by the MTSRF Research Investment Strategy (RIS), which was developed from extensive consultation and negotiation on the research and information priorities for understanding and managing North Queensland's public environmental assets. The RIS represents the collective view of scientific experts, business and industry leaders, government agencies, NGOs and community groups. The RIS provides a framework for the development of a suit of collaborative, multidisciplinary research projects that address aspects of priority environmental issues in North Queensland. Each research project is then brokered, funded and reviewed annually during the development of the MTSRF Annual Research Plans.

This document presents the fourth and final MTSRF Annual Research Plan (ARP4) and sets out the research objectives, research staff and institutions, and the cash and in-kind contributions of research partners for each of the 47 research projects being implemented within the four overarching research themes of the MTSRF program. The ARP4 outlines the Australian Government's investment of $7.6 million into priority research activities in 2009/10, building on the $22.8 million research investment made during ARP1, ARP2 and ARP3. In ARP4, each project is focussed on delivering significant outputs commensurate with the four-year investment. The enhanced delivery of those outputs through Theme 5 will be a considerable task involving a significant expansion of communication activities conducted by the Reef and Rainforest Research Centre as outlined in this year's schedule.

Theme 1: Status of the Ecosystems

A clear understanding of the current condition of the North Queensland's environmental assets is fundamental to achieving sustainable use of those assets by industry and communities, to supporting ongoing management of those assets, and to help inform policy, both for North Queensland and nationally. Theme 1 is comprised of four inter-related

Programs, each of which concentrates on a specific component of North Queensland's natural and cultural heritage, and delivers reports on the environmental condition and socio-economic value of key assets, possible threats to their continued well-being, and, importantly, cost-effective methods for longer-term assessment and management. The total investment in Theme 1 is $5,117,206.

Program 1 focuses specifically on assessing the status of the Great Barrier Reef (GBR), Queensland's largest and most valuable environmental asset, through the development and introduction of robust indicators of health and continued monitoring of integral habitats (i.e. reef and seagrass communities). The outcomes of the five projects conducted within Program 1 will provide a greater understanding of both current and historical GBR system dynamics, and will continue the collection of large-scale, long-term data on the condition of this iconic ecosystem. This information is essential for assessing the realised and potential impacts of threats, such as climate change and declining water quality, the implementation of adaptive management and, particularly the long-term sustainable use by and profitability of reef-dependent industries. Such information is the foundation of *State of the Environment* reporting, particularly the Great Barrier Reef Marine Park Authority's Outlook Report and international obligations for World Heritage reporting. In addition, the development of the e-Atlas (Project 1.1.5) is an integral component of Program 1, providing a publicly accessible web-based integrated knowledge management system to enhance evidence-based decision making for effective management and long-term sustainable use of North Queensland's natural assets. The e-Atlas is a portal (www.e-atlas.org.au) that provides access to the data, meta-data and information handling, spatial mapping and analytical tools to collate, integrate, share and analyse the vast array of multi-source bio-physical and socio-economic information required to model, map and manage these environmentally, economically and culturally valuable systems effectively. The e-Atlas will be the repository for MTSRF meta-data and is an integral component of Theme 5: *Enhancing Delivery* (outlined below), communicating information encompassing the entire MTSRF program.

Program 2 is comprised of four inter-related sub-projects focussed on assessing and reporting the condition of North Queensland's Wet Tropics rainforests and catchments, particularly low-land rainforests that are increasingly threatened, and the identification of condition indicators and filling of knowledge gaps to develop rigorous baselines for comprehensive condition monitoring of these valuable terrestrial ecosystems. The outcomes of Program 2 feed directly into Programs 5ii (*Climate change – Rainforest and Catchments*) and 9 (*Sustainable Use – Rainforests and Catchments*) and will contribute to State of Environment and World Heritage reporting for the Wet Tropics World Heritage Area and North Queensland's coastal catchments.

Program 3 is focussed specifically on Torres Strait and has evolved over the lifetime of the MTSRF to meet the specific needs of the region. During the initial two years, work conducted identified key issues that could be developed into a framework for assessing the environmental and social assets of Torres Strait. In the third year, research efforts focussed on the potential impacts of climate change, an ecological assessment of wild commercial sponges, an investigation of co-management for hand collectable fisheries and the repatriation of knowledge. Research conducted in the fourth year will continue to focus on these aspects through the implementation of five projects that concentrate on the potential for developing ecologically sustainable economic opportunities for Torres Strait and to increase community resilience to environmental change by integrating scientific and socio-economic assessments to develop recommendations for climate change resilience and adaptation and planning in Torres Strait. Moreover, mechanisms to repatriate knowledge in culturally appropriate ways will be developed and used to raise awareness of environmental issues and build community resilience in Torres Strait. The outcomes of research conducted within this Program has been generated through close collaboration with major stakeholders

in Torres Strait, including Torres Strait Regional Authority Executive Members, the Community Liaison Officer, and relevant management agencies.

Program 4 is focussed specifically on the current status and future trends in populations of marine and rainforest species of conservation concern. The two projects implementing the marine component of Program 4 are conducting critical biological, social and economic research assessing the condition and trends of dugongs, marine turtles and coastal dolphins in the Great Barrier Reef World Heritage Area and Torres Strait and evaluating management options to improve their status. Owing to nature and distribution of turtle and dugong populations, and their cultural importance to mainland and Torres Strait Indigenous communities, this aspect of Program 4 is strongly tied to Program 3 (above). The third project conducted within Program 4 is focussed on reporting the condition of threatened species and communities in the rainforest and coastal catchments of North Queensland and is identifying management options to mitigate risks, and reduce threats to iconic species such as cassowaries and arboreal marsupials, and endangered habitats.

Theme 2: Risks and Threats to Ecosystems

Options for promoting adaptation to climate change, increased climate variability and mitigation of the impacts of invasive species have been identified as key priorities for North Queensland. Research conducted within Theme 2 is comprised of three inter-related Programs that are evaluating the likely impacts of climate change on the Great Barrier Reef (Program 5i) and rainforests and catchments (Program 5ii), the potential impacts of invasive species (Program 6), identifying sources of resilience, and developing practical responses to mitigate these impacts. The total value of Theme 2 is $4,010,480.

Climate change is widely recognised as probably the greatest threat to the long-term well-being of the Great Barrier Reef. Each of the four projects implemented within Program 5i investigates high priority issues associated with the likely impacts of climate change on the GBR. The outcomes of research conducted within Program 5i are improving regional scenarios and understanding of future climate change on the GBR, improving understanding of the physiology of coral bleaching and the potential for coral adaptation to increased sea temperatures, incidence of coral disease, the role of herbivory as a critical factor underpinning reef resilience, the impacts of climate change on higher trophic levels (i.e. sea birds), and enhancing our knowledge of the combined, interactive effects of climate change and water quality on the GBR.

Program 5ii is implemented through four integrated projects that examine the likely impacts of climate change on North Queensland's tropical forests. These projects have developed regional scenarios and improved our understanding of future changes in temperature, patterns of rainfall, clouds, extreme weather events and CO_2 dynamics in North Queensland's terrestrial environments. These projects have also provided greater understanding of the risks of extinction to biodiversity and the potential of Wet Tropics vertebrates and plant communities to adapt to predicted future climate change-driven variability in water stress, flowering and fruiting, carbon use and storage.

Program 6 examines the threats and impacts of invasive pests in the Great Barrier Reef and the Wet Tropics rainforest. In the GBR, research is focussed on the current and potential risks of invasive marine toxic dinoflagellate species. In the Wet Tropics rainforest, research is building on and refining a rapid response strategy to incursion by invasive species by detailing ecological dispersal traits (e.g. introduction history, distribution, abundance, taxonomy, population parameters, reproduction, environmental tolerances, habitat preferences, movement, feeding habits), current or potential impact of native and exotic species. The functional classification of traits that influence the invasive spread potential of pre-emergent or new invasives are being used to develop data-based predictions of how

invasives, particularly vertebrate-dispersed plants and fish, spread through rainforest landscapes. This allows managers to assign pre-emergent or new species to risk categories based on spread characteristics of similar species already in Australia and to develop management response strategies based on these classifications.

Theme 3: Halting and Reversing the Decline of Water Quality

High quality water quality is vital to the ongoing health of the Great Barrier Reef, the Wet Tropics rainforest, and for the communities, industries and ecosystems that are reliant on these natural ecosystems. Research within this theme will be conducted under Program 7, which currently consists of six projects that are examining the effectiveness of management actions implemented under the Reef Water Quality Protection Plan (Reef Plan) and those to be taken under the Reef Rescue Plan, and improving understanding of how the condition of freshwater, estuarine and marine ecosystems are linked to terrestrial processes. This Program is identifying robust indicators for water quality in freshwater, estuarine and marine ecosystems that will enable the development of tools to improve water quality monitoring and determine pollutant thresholds of potential concern for exposure of key ecosystems to sedimentation, light, nutrients and herbicides. In addition, improved approaches for the estimation of end of river loads are being developed, and catchment specific tracers are being used to determine the links between terrestrial and marine water quality to identify areas of the GBR lagoon that are at greatest risk of exposure to land-based pollutants. Predictive tools incorporating the likely impacts of changes in land use, management and climate on the flow and water quality regimes and ecological dynamics in the wetlands and floodplains of catchments adjacent to the GBR are also being developed to identify and introduce sustainable environmental targets and associated land use and land management practices. The outcomes of research conducted within Program 7 will provide valuable information to assist the evaluation of the Reef Rescue Plan. The total value of Theme 3 is $2,877,632.

Theme 4: Sustainable Use and Management of Natural Resources

The sustainable use of North Queensland's natural assets is critical to maintaining the environmental, social and economic values of the region. Research undertaken within Theme 4 is providing knowledge and options for promoting sustainable use and minimising adverse impact on these natural assets. Research conducted within Theme 4 is implemented under two Programs: Program 8, which focuses on the sustainable use and management of marine resources of the Great Barrier Reef; and Program 9, which focuses on the sustainable use and management of marine resources of the Wet Tropics rainforests. The total value of Theme 4 is $6,033,804.

In ARP4, Program 8 consists of seven projects that examine various aspects associated with the sustainable use of the GBR, particularly the ecological and socio-economic impacts of the GBR Zoning Plan. Program 8 addresses specific issues of end user relevance, in particular the assessment of the influence of the GBR Zoning Plan on inshore and inter-reefal habitats and biodiversity of the GBR, the analysis of the biological parameters and current and historical patterns of use of key inter-reef fish species, particularly from industry and communities, the connectivity and dispersal of exploited fish species, particularly coral trout, the assessment of the effectiveness of green zones in augmentmenting larval supply to fish populations, the analysis of the cost/benefits of the GBR zoning on tourism, recreation and fishing, the social and economic valuation of key marine species, the identification of key trends and drivers of visitor usage and economic impacts of reef-related tourism to North Queensland, and examination of the risks associated with marine stingers, particularly irukandji, in North Queensland.

Research conducted within Program 9 is aligned directly with the needs of the Department of the Environment, Water, Heritage and the Arts, Wet Tropics Management Authority, Terrain NRM Ltd, Indigenous groups, industry and other key stakeholders based in the Wet Tropics bioregion, and is providing the knowledge to support the management of the Wet Tropics World Heritage Area, sustainable economic activities (notably agriculture, agroforestry, tourism and Indigenous enterprises), while enhancing biodiversity and maintaining essential ecosystem services across the entire Wet Tropics landscape. The Program is implemented through seven inter-related projects that examine a diversity of aspects of sustainable use, planning and management of environmental assets of North Queensland's tropical rainforests and adjacent Wet Tropics. The outcomes of Program 9 include a valuation of residential contribution to biodiversity and ecosystem services in regional and local planning areas, identification of biodiversity values and metrics for incorporation into regional and local planning mechanisms, identification of major issues relating to tourist motives and behaviours for visiting the Wet Tropics, determination of key trends and economic contribution of Wet Tropics tourism to North Queensland, determination of impacts of tourism in the Wet Tropics World Heritage Area and mitigation strategies for adverse impacts, a toolkit and indicators for monitoring and evaluating reforestation success, methods to optimise reforestation success, an optimisation model for regional investment in reforestation and management, and assessment of Indigenous natural resource use within the Wet Tropics World Heritage Area, and optimisation of traditional owner knowledge and engagement in natural resource management particularly water resources and changes to water quality and resulting ecological impacts.

Theme 5: Enhancing Delivery

Activities conducted within Theme 5 are based on the premise that if the economic, social, cultural and environmental values of this region are to be maintained despite rapidly increasing pressures, then management needs to be sustainable and informed by sound science. The MTSRF is producing scientific information with the specific purpose of enabling management, policy and practice to become more sustainable. Activities conducted within Theme 5 are focussed on the successful delivery of the outcomes of MTSRF research through the development and implementation of strategic, creative, and effective ways of communicating synthesised scientific information to targeted end users, particularly through the identification of key messages and appropriate audiences, effective delivery of those messages, and the evaluation of delivery effectiveness. The implementation of Theme 5 is the specific responsibility of the Reef and Rainforest Research Centre Ltd. This is carried out through three projects, the first of which was developed in consultation and agreement with researchers participating in the MTSRF and partly funded through Themes 1-4. Outputs include high quality digital video footage of science activities being conducted through the MTSRF with appropriate scripts for use in describing and documenting research being conducted. Footage is available on the website and available for use by all research organisations within the MTSRF for communicating their research findings. The latter two projects are assisting communication between MTSRF researchers and key groups, particularly tourism groups and Indigenous rainforest people, within the Wet Tropics rainforests. The total value of Theme 5 (Program 10) is $797,500.

This fourth MTSRF Annual Research Plan will be implemented through the MTSRF's contracted programme manager in North Queensland, the Reef and Rainforest Research Centre Ltd. For further information about the implementation of the MTSRF in North Queensland, visit the Centre's website (www.rrrc.org.au).

CONTENTS

ACRONYMS

AAC	Advanced Analytical Centre (James Cook University)
ABS	Australian Bureau of Statistics
ACC	Australian Canopy Crane
ACCSP	Australian Climate Change Science Program
ACTFR	Australian Centre for Tropical Freshwater Research
ADFA	Australian Defence Force Association
AFFFM	Australian Farm Forestry Financial Model
AFMA	Australian Fisheries Management Authority
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
AIMS	Australian Institute of Marine Science
AIMS LTMP	Australian Institute of Marine Science Long Term Monitoring Program
AIMS LTMT	Australian Institute of Marine Science Long Term Monitoring Team
AMC	Australian Maritime College
AMPTO	Association of Marine Park Tourism Operators
ANU	Australian National University
ARC	Aboriginal Rainforest Council
ARP	Annual Research Plan
AWS	Automatic Weather Station
BBN	Bayesian Belief Network
BMP	Best Management Practice
BRS	Bureau of Rural Sciences
CCI	Coastal Catchments Initiative
CEO	Chief Executive Officer
CERF	Commonwealth Environment Research Facilities
CHIMS	Cultural Heritage Information Management System
CMM	Centre for Microscopy and Microanalysis
COTS	Crown-of-thorns starfish
CQU	Central Queensland University
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Commonwealth Department of Agriculture, Fisheries and Forestry
DBH	Diameter Breast Height
DEEDI	Queensland Department Employment, Economic Development and Innovation
DERM	Queensland Department of Environment and Resource Management
DEW	Commonwealth Department of the Environment and Water Resources
DNA	Deoxyribonucleic Acid
DSS	Decision Support System
EC	Eddy Covariance
ELF	Effects of Line Fishing
FNQ	Far North Queensland
FRC	Fitzroy River Catchment

FTE	Full-time equivalent
GAC	Girringun Aboriginal Corporation
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
GCM	Global Climate Model
GIS	Geographical Information System
GPS	Global Positioning System
GU	Griffith University
IPCC	Intergovernmental Panel on Climate Change
ITQ	Individual Transferable Catch Quota
JCU	James Cook University
LAI	Leaf Area Index
LTMP	Long Term Monitoring Program
LTMT	Long Term Monitoring Team
MAC	Ministerial Advisory Council
MATS	Management Action Targets
MBI	Market Based Instrument
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MTSRF	Marine and Tropical Sciences Research Facility
NASA	National Aeronautics and Space Administration
NGO	Non Government Organisation
NHT	Natural Heritage Trust
NOAA	National Oceanic and Atmospheric Administration
NRM	Natural Resource Management
NSW	New South Wales
PES	Payment for Environmental Services
QDMR	Queensland Department of Main Roads
QME	Queensland Mines and Energy
QPIF	Queensland Primary Industries and Fisheries (DEEDI)
QLD	Queensland
QPWS	Queensland Parks and Wildlife Service
QSIA	Queensland Seafood Industry Association
RAP	Representative Areas Program
RCA	Reef Check Australia
RCT	Resource Condition Targets
RE	Regional Ecosystems
RIS	Research Investment Strategy
RSES	Research School of Earth Sciences
RRMMP	Reef Rescue Marine Monitoring Plan
SAR	Synthetic Aperture Radar
SES	Social-Ecological System
SST	Sea Surface Temperature

TBA	To Be Advised
TBC	To Be Completed
TEK	Traditional Environmental Knowledge
The Plan	Annual Research Plan
TLJV	Tropical Landscapes Joint Venture
TS	Torres Strait
TSI	Torres Strait Islands
TSRA	Torres Strait Regional Authority
TTNQ	Tourism Tropical North Queensland
UM	The University of Melbourne
UQ	The University of Queensland
UVC	Underwater Visual Census
VOC	Volatile Organic Carbon
WAMSI	West Australian Marine Science Initiative
WFHC	Water for a Healthy Country
WHA	World Heritage Area
WQ	Water Quality
WQIP	Water Quality Improvement Plan
WTMA	Wet Tropics Management Authority
WTQWHA	Wet Tropics of Queensland World Heritage Area
WTWHA	Wet Tropics World Heritage Area

INTRODUCTION

The Marine and Tropical Sciences Research Facility (MTSRF) programme is a $40 million Australian Government initiative. It is a sub-programme of the Commonwealth Environment Research Facilities (CERF) programme which is investing $100 million in the four years to June 2010.

The CERF and MTSRF programmes aim to improve Australia's capacity to understand and respond to priority environmental concerns affecting national environmental assets. The MTSRF programme is focused specifically on ensuring the ongoing health of:

- The Great Barrier Reef and its catchments;
- Tropical rainforests including the Wet Tropics World Heritage Area; and
- Torres Strait.

The programme supports world-class research to underpin environmental resource management and policy development. It focuses on collaboration, partnerships, co-investments and on making data and research information freely and publicly available. For information about the CERF and MTSRF programmes see:
http://www.environment.gov.au/cerf

Research Investment Strategy

Research funding is guided by the MTSRF Research Investment Strategy (RIS). This strategy is the result of intensive consultation and negotiation on the research and information priorities for understanding and managing North Queensland's public environmental assets. The RIS represents the collective view of scientific experts, business and industry leaders, government agencies, NGOs and community groups.

Stakeholders are actively involved in planning, implementing and reviewing research work. Their engagement is an important part of the MTSRF philosophy, and is intended to ensure that research outcomes are not only scientifically rigorous, but also meet the information needs of environmental managers and policy makers. For further information about the RIS see: http://www.environment.gov.au/cerf

Annual Research Plans

The RIS guides the development of collaborative, multidisciplinary research projects by identifying the big environmental issues to be addressed. Research projects are then funded and reviewed annually through the MTSRF Annual Research Plans.

A central feature of MTSRF research programme is its ability to link and integrate research activity and information across the geographical region and across the full scope of scientific disciplines. This promotes the development of useful solutions to complex and interrelated issues facing the region including:

- Water quality management from the upper catchment through to the reef;
- Climate change impacts on ecosystems and water quality; and
- Managing resource use by multiple industries and interest groups.

The highly collaborative approach of the MTSRF research programme brings research staff and students from the leading institutions together with stakeholders to form the research questions which will deliver usable outcomes.

This is the final MTSRF Annual Research Plan (ARP4). It directs $7.618 million into priority research activities in 2009/10 and builds on the $22.856 million research investment made during ARP1, ARP2 and ARP3.

The following pages set out the research questions, research staff and institutions, the Australian Government funding investment, and the cash and in-kind contributions of research partners. This ARP will be implemented through the MTSRF's contracted programme manager in North Queensland, the Reef and Rainforest Research Centre Ltd. For further information about the implementation of the MTSRF in North Queensland see: http://www.rrrc.org.au

Cash and In-kind Support for MTSRF Research

Theme	MTSRF Cash	Other Cash	In-kind	Total
1. Status of the Ecosystems	$2,038,000	$45,000	$3,034,206	**$5,117,206**
2. Risks and Threats to the Ecosystems	$1,350,000	$134,576	$2,525,904	**$4,010,480**
3. Halting and Reversing the Decline of Water Quality	$1,175,000	-	$1,702,632	**$2,877,632**
4. Sustainable Use and Management of Resources	$2,258,275	$396,450	$3,379,079	**$6,033,804**
5. Enhancing Delivery	$797,500	-	-	**$797,500**
Total	**$7,618,775**	**$576,026**	**$10,641,182**	**$18,836,622**

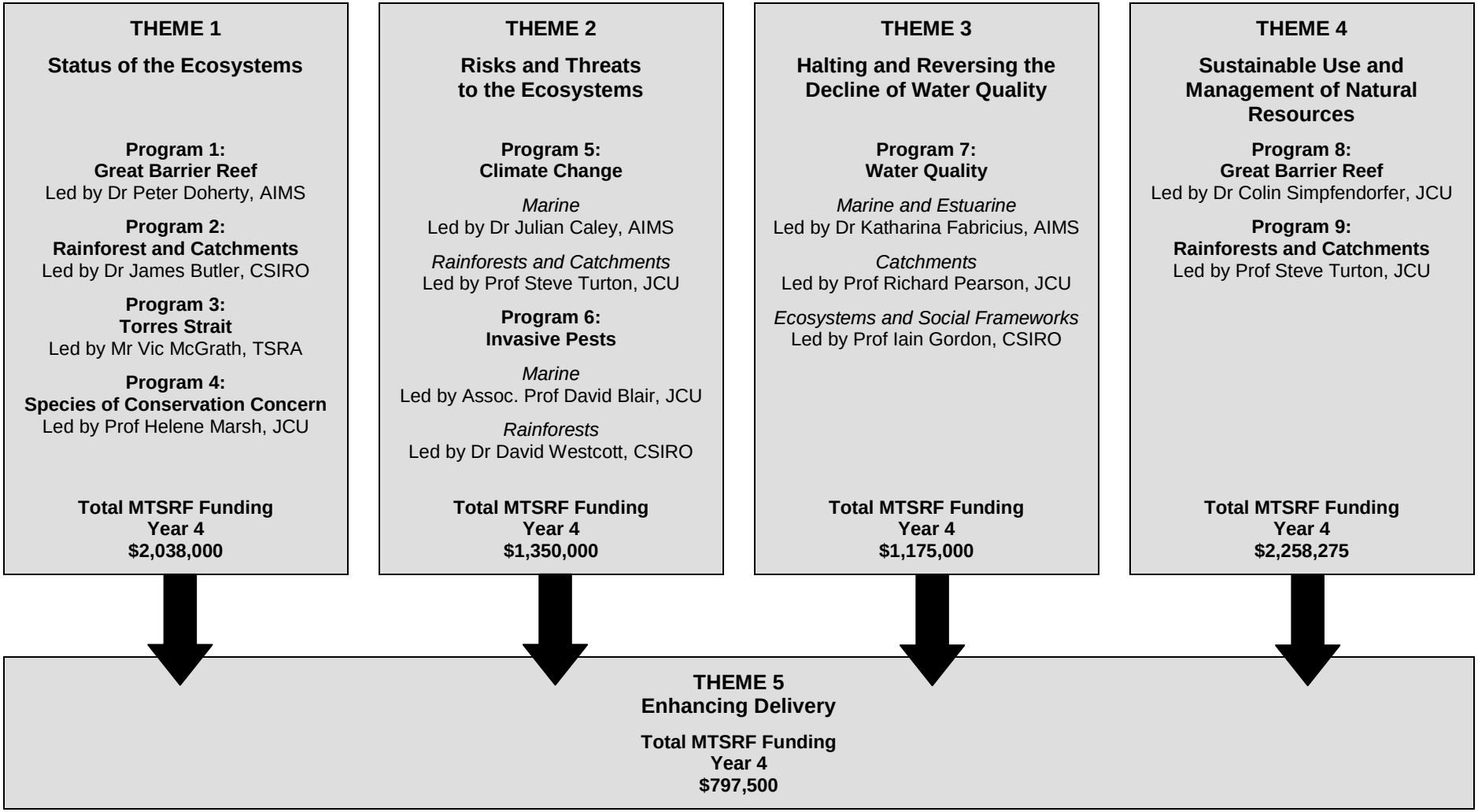


Figure 1: Outline of the MTSRF Research Programme structure.

THEME 1
STATUS OF THE ECOSYSTEMS: UNDERSTANDING THE CONDITION, TREND AND INTERDEPENDENCIES OF ENVIRONMENTAL ASSETS OF NORTH QUEENSLAND

It is important that government, natural resource managers, protected area managers, industry and the national and international community have a clear understanding of the state of North Queensland's key environmental assets. This is particularly important to foster sustainable use by the industries reliant on the environmental assets, to support ongoing management of the assets and to help inform policy direction, both for North Queensland and nationally. To achieve this, the MTSRF will produce reports on the state of key assets, identifying possible threats, the socio-economic values of the assets and, importantly, cost-effective methods for longer-term assessment and management.

Theme 1 Budget Summary

Program	Title	MTSRF	Other Cash	In-kind	Total
Program 1	GBR Status and Trends	$775,000	-	$1,649,849	$2,424,849
Program 2	Rainforests Status and Trends	$350,000	-	$479,918	$829,918
Program 3	Torres Strait – Status, Use and Trends	$393,000	$45,000	$399,231	$837,231
Program 4	Species and Communities of Conservation Concern	$520,000	-	$505,208	$1,025,208
Total		**$2,038,000**	**$45,000**	**$3,034,206**	**$5,117,206**

The total value of Theme 1 is $5,117,206.

PROGRAM 1
STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE GREAT BARRIER REEF

Program Leader and Host Organisation

Dr Peter Doherty, Australian Institute of Marine Science (AIMS)

Program 1 Budget Summary

	Cash	In-kind	Total
MTSRF	$775,000	-	$775,000
Other	-	$1,649,849	$1,649,849
Total	**$775,000**	**$1,649,849**	**$2,424,849**

The Great Barrier Reef (GBR) is Queensland's largest and most valuable environmental asset, deserving of its World Heritage listing, and generating annually $5.8 billion gross value for Australia[1]. The largest industry in the Great Barrier Reef Marine Park is marine tourism, which values environmental quality.

The Program will focus on delivering robust indicators of reef health and identifying threshold of potential concern for the GBR ecosystem. The Program contains two long-term monitoring programs of iconic ecosystems (coral reefs and seagrasses). These reports of condition and response will be linked with research in other MTSRF Programs, notably those for water quality and climate change and will feed into the e-Atlas (MTSRF Project 1.1.5). The program will also develop an early warning system for outbreaks of crown-of-thorns starfish to allow the tourism industry to prepare tactical responses. Support for community-based monitoring (Reef Check Australia) of tourism intensive sites will also be a feature of the Program.

There will be two broad-scale assessments of the ecological effects of the GBR Zoning Plan on mid-shelf and outer-shelf reefs. These will be linked with GBR Zoning Plan assessments being undertaken by the MTSRF Sustainable Use Program (Program 8) on inshore reefs and shoals, which will also include social and economic indicators of changes associated with the zoning.

The risk mapping and monitoring products generated by the Status and Trends Program are some examples of the information required to inform integrated, proactive management. The full picture of raw information flows is very complex. Thus, the Program will collaborate with the relevant managing agencies and user groups to provide information that will enable the development of Integrated Reports for the GBR by contributing to the e-Atlas, which will utilise a structured framework for assimilating data from multiple sources with an emphasis on quantitative indicators of condition and trend and performance assessment of systems against thresholds of critical concern. Moreover, the e-Atlas will provide the analytical tools to: model and map ecosystem properties, identify the main risk and resilience factors influencing the GBR and assess their biological, social and economic impacts. This type of

[1] Access Economics (2005) *Measuring the economic and financial value of the Great Barrier Reef Marine Park*. Report prepared for the Great Barrier Reef Marine Park Authority, Townsville.

information will be used to assist the managing agencies in *State of the Environment* reporting, particularly the GBRMPA Outlook Report and international obligations for World Heritage periodic reporting, and will be a valuable for day-to-day management of the GBR and for policy development. This integration will be a distinguishing feature from work done previously under the Cooperative Research Centre model and is the lead project in this Program. Finally, the Program will strengthen community support for, and use of, this product by linking community-based action programs with the outputs of the data integration and synthesis process.

Projects

1.1.1 Identification of indicators and thresholds of concern for ecosystem health on a bioregional scale for the Great Barrier Reef $60,000

1.1.2 Condition and trend of the GBR ecosystem: Indicators and thresholds of potential concern, and ecological effects of the GBR Zoning Plan on mid and outer reefs..... $320,000

1.1.3 Condition, trend and risk in coastal habitats: Seagrass indicators, distribution and thresholds of potential concern $200,000

1.1.4 Dating and mapping historical changes in GBR coral communities..... $50,000

1.1.5 Atlas of Australia's Tropical Lands and Seas (e-Atlas) $145,000

PROGRAM 1: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE GREAT BARRIER REEF

Project 1.1.1: Identification of indicators and thresholds of concern for ecosystem health on a bioregional scale for the Great Barrier Reef

Project Leaders and Host Organisations

Associate Professor Michelle Waycott, James Cook University
Dr Hugh Sweatman, Australian Institute of Marine Science

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Hugh Sweatman	AIMS	Reef ecology, monitoring	0.1
Biostatistician	AIMS	Numerical analysis	0.1
LTMP fish ecologists	AIMS	Reef fish ecology, monitoring	0.2
Dr Michelle Waycott	JCU	Project leader, indicators, reporting, communication	0.1
Ms Alana Grech	JCU	Marine ecology	0.05
Mr Len McKenzie	QPIF	Seagrass ecology and water quality monitoring	0.05
Dr Jane Mellors	QPIF	Seagrass and Water Quality Monitoring	0.05
Dr Korjent Van Dijk	JCU	Seagrass ecology	0.2
Dr Catherine Collier	JCU	Seagrass ecology	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Laurence McCook, David Wachenfeld
DEWHA	Kevin Gale

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

(a) Identify available indicators of condition and trend in biodiversity, ecosystem health and thresholds of concern or triggers for management action for non-reefal coastal systems (seagrasses) (with reference to the GBR Bioregions, 2003) that are appropriate for reporting the condition and trend in the health of the GBR ecosystem.

(b) Develop a conceptual approach to testing the further development of indicators of condition and trend in the health of the GBR ecosystem as new information becomes available.

(c) Assess currently used indicators for the links between reef water quality and the condition and trend in the health of the GBR and develop new indicators if appropriate.

(d) Develop prospective approach to identifying thresholds of concern for coastal marine plant community health indicators for the GBR.

(e) To synthesise broad spatial and the long temporal data collected by the AIMS LTMP on herbivorous fishes on the GBR

Herbivorous fishes are considered to have a crucial role in the resilience of reefs because they consume macroalgae that, under some circumstances, occupy vacant space caused by disturbance and impede recolonisation by hard corals. Herbivorous fishes include parrotfishes, surgeonfishes, rabbitfishes, blennies and reportedly, batfishes. As well as groupings based on taxonomy, herbivorous reef fishes can be divided into a number of guilds that feed in different manners (scrapers, croppers, detritus feeders, etc). Theories of ecological resilience hold that "functional redundancy" – the presence of more than one species that fulfils each ecological function and response diversity – meaning that populations of the species in a functional group do not all show the same response to changes in the environment, are the bases of community resilience. The presence of abundant and diverse assemblages of herbivorous fishes is often considered an indicator of a healthy reef.

The feeding guilds of many larger herbivorous reef fishes have been described, and one component of MTSRF Project 2.5i.3 (*Resilience to climate change*) has been an assessment of grazing and grazing capacity of herbivorous fishes on two cross-shelf transects, one in the northern GBR and another in the central GBR, plus recent surveys at a range of inshore sites. To date, it is not known how herbivore abundance varies over the extent of the GBR, nor is it known how spatial patterns vary over time. An early output from MTSRF Project 2.5i.3 was a report reviewing the state of knowledge of herbivory by fishes on the GBR (Cvitanovic *et al*. 2007[2]) which states:

> "It is frequently assumed that a surfeit of data exists on herbivore distributions and biomass on the GBR, however Table 2 (containing published baseline data on the distribution, abundance and biomass of herbivorous fishes on GBR) reflects the inadequacy of our understanding of populations of herbivores along the length of the GBR as a whole. Interesting cross-shelf patterns in herbivore populations and species composition have been discerned at particular latitudes … but the scope of our information needs to be extended across a wider range of latitudes, bioregions and habitats to gain a more holistic picture of herbivore populations on the GBR."

The AIMS LTMP has surveyed the suite of three major taxonomic groups of herbivorous fishes: parrotfishes, surgeonfishes, rabbitfishes, using a standardized survey method in a standard habitat on reefs in three positions across the continental shelf at six latitudes over seventeen years. Surveys also record information on the benthic community and in that time these reefs have been affected by several kinds of disturbance that removed coral cover to varying extents.

A preliminary summary of abundances of all herbivorous fishes counted by the LTMP across the GBR in 2007 (Delean and De'ath 2008[3]) showed that the total numbers varied across and along the shelf.

[2] Cvitanovic, C., Fox, R. J. and Bellwood, D. R. (2007) *Herbivory by fishes on the Great Barrier Reef: A review of knowledge and understanding*. Unpublished Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (33 pp.).

[3] Delean S. and De'ath G (2008) *Spatial and temporal patterns of indicators of reef health on the Great Barrier Reef*. Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (116 pp).

Work conducted under this objective during the final year of the MTSRF would summarise the LTMP data on herbivores to estimate and map, (1) the spatial variation in numbers of herbivores across the GBR, and (2) changes in those herbivore communities over seventeen years, relating these to habitat changes. The variation in distribution of assemblages of herbivorous fishes will be summarised both by taxonomic groups and by feeding guilds. This will be a significant step towards a holistic picture of herbivore populations and provide a general context for the interpretation of localised, short term studies. Phase shifts have occurred on very few LTMP survey reefs, but the relationship between observed abundance and composition of herbivore assemblages, the extent of loss of coral through disturbances such as Acanthaster planci outbreaks and the subsequent extent of macroalgal increase may help to identify the critical abundances of herbivore guilds that are necessary for community resilience and regions of the GBR where those critical abundances are lacking.

Project/ Task Methodology

Objectives (a)-(d) are led by JCU and will be achieved by:

- Contributing specific information to workshop on indicators of condition and trend in health of non-reefal coastal GBR systems (seagrasses and potentially mangroves) as a part of the Reef Rescue Marine Monitoring Program science synthesis activities;
- Providing existing data sets that are available for science synthesis to evaluate the indicators arising from the workshop listed above (link to MTSRF Project 1.1.3 and extensions);
- Reviewing the efficacy of indicators of ecosystem health (non-reefal) in context of Science synthesis outcomes where current data are available (identify links to MTSRF projects monitoring biodiversity and the health of the GBR ecosystem where future opportunities for field testing may occur);
- Utilising established the working group to evaluate the outcomes of the science synthesis workshop outcomes, and through links to MTSRF Projects 1.1.3; and
- Synthesising the results into a final report on “Indicators and thresholds of concern for the status and trends of the health of the Great Barrier Reef for coastal ecosystems”.

Objective (e) is led by AIMS and will be achieved by:

- Extending this project’s previous work, extensive statistical analysis of AIMS LTMP data will be performed to determine patterns in the distributions of herbivorous fishes in space and time, and the relationship between observed abundance and composition of herbivore assemblages, the extent of loss of coral through disturbances such as Acanthaster planci outbreaks and the subsequent extent of macroalgal increase. The outcomes of these analyses will be presented in a format similar to reports previously produced by this project, such as “Spatial and temporal patterns of indicators of reef health on the Great Barrier Reef.”, and in a manuscript.
- Final data products will be integrated into the e- Atlas for public dissemination.

Project Outputs/Outcomes

Synthesis of broad spatial and the long temporal data collected by the AIMS LTMP on herbivorous fishes on the GBR

In previous years, this project has produced one report on potential indicators for reef health and another: “*Spatial and temporal patterns of indicators of reef health on the Great Barrier Reef*” mapped the spatial distribution of a large number of variables that are related to coral reef health. In addition, it included some multivariate indices of reef health and summaries of the changes in a number of variables over the seventeen year duration of the AIMS Long-term Monitoring Program. This report showed that: (1) reefs within the central inner-shelf

region exhibited relatively poorer health; (2) reefs with poorer health occurred in areas of poorer water quality; and (3) benthic indicators showed a consistent decline in reef health in inner and mid-shelf regions during the past decade, although there were relative improvements in the health of fish communities, particularly on outer shelf reefs.

Tasks undertaken during ARP3 built on this earlier work by focussing on operationalising the concept of resilience for reefs of the GBR. The first task involved mapping the distribution of juvenile corals (two to five years of age, rather than newly settled individuals) of several taxa across the GBR in order to assess the maintenance and regenerative capacity of coral populations following disturbances; a key part of reef resilience. The greatest densities of juvenile corals (all taxa and adjusted for available substrate) were found in the Wet Tropics region and the mid-shelf Swain reefs. Previous work examining potential indices of reef health (reports mentioned above) showed that the Wet Tropics region had the lowest coral cover of any region surveyed by the AIMS LTMP and was in relatively poor health according to a multivariate index of relative coral reef health based on coral cover, macroalgal cover and recent *Acanthaster planci* activity. However, the high densities of juvenile corals (~2-5 years of age) on Wet Tropics reefs suggest that these reefs are resilient despite losing considerable coral cover as a result of *Acanthaster* outbreaks and tropical storms.

The second involved estimating rates of recovery of hard coral cover for the four broad groups of coral communities that occur on the GBR. Knowledge of the mean and range of rates of recovery that have been observed indicate the magnitude of rates of recovery that can be expected and so provide a context for assessing relative resilience for contemporary reefs.

The task proposed for ARP4 examines another component of reef health and resilience: herbivorous fishes. Herbivorous reef fishes are thought to play a key role in suppressing the growth of macroalgae when coral cover is reduced by disturbance, allowing hard coral to recover. The descriptions of spatial and temporal patterns in the distributions of different taxa and functional groups of herbivorous fishes based on the AIMS LTMP data will be reported publicly to MTSRF and on the e-Atlas, and within scientific journals within the project's duration. The primary outcome of the project in ARP4 will be a more complete picture of geographic and temporal variation in herbivore populations on the GBR and a broad context for reef managers to interpret smaller scale studies or ecological events. This continues the general theme of Project 1.1.1 over the term of the MTSRF.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
a	Workshop involvement in Reef Rescue MMP science synthesis to address Reef Rescue Marine Monitoring Program indicators with broad participation [JCU/GBRMPA/QPIF/AIMS]	September 2009
b	Conduct synthesis analysis of outcomes from coastal monitoring data currently available and provide outline of report.	December 2009
c	Working group evaluation of Science Synthesis outcomes report.	March 2010
d	Report on "Indicators and thresholds of concern for the status and trends of the health of the Great Barrier Reef for coastal ecosystems"	June 2010
e	Analysis of spatial and temporal patterns in the distribution of herbivorous fishes from LTMP data set as a potential indicator of coral reef health.	June 2010

Project 1.1.1 Milestone Payments 2009/10

For 2009/10 outputs only **Milestones**	Date	MTSRF AIMS	MTSRF JCU
• Signing of contract		$14,750	$14,750
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10		
Report 1 submission: • Report of relevant outcomes from Workshop on monitoring GBR systems and developing indicators of Reef Health (with appropriate attribution of MTSRF Funding) (September 2009) • Progress report (with appropriate attribution of MTSRF Funding) on analyses of spatial and temporal patterns in distribution of herbivorous reef fishes from AIMS LTMP data [AIMS]. • Summary of any communication activities undertaken [AIMS and JCU].	15 Nov 2010		$7,375
Report 2 submission: • Summary document outlining synthesis outcomes from Workshop and subsequent analysis [JCU].	21 Feb 2010	$7,375	
Report 3 submission: • Delivery of final report (with appropriate attribution of MTSRF funding) on "Indicators and thresholds of concern for the status and trends of the health of the Great Barrier Reef for coastal ecosystems" [JCU]. • Meta-data describing all data generated by MTSRF Project 1.1.1 lodged on the e-Atlas [JCU].	1 Jun 2010		$7,375
Report 4 submission: • Final report (with appropriate attribution of MTSRF funding) on analyses of spatial and temporal patterns in distribution of herbivorous reef fishes from AIMS LTMP data [AIMS]. • Meta-data describing all data generated by MTSRF Project 1.1.1 lodged on the e-Atlas [AIMS].	15 June 2010	$7,375	
MTSRF Funding		**$29,500**	**$29,500**

Project 1.1.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$59,000	-	$59,000
MTSRF Visual Documentation*	$1,000	-	$1,000
AIMS	-	$25,000	$25,000
JCU	-	$68,615	$68,615
Total	**$60,000**	**$93,615**	**$153,615**

* A total of $1,000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

AIMS Project 1.1.1 Budget 2009/10

Item	MTSRF Funds	AIMS In kind	Total Cost
Salaries	$25,000	$25,000	$50,000
Operating	$3,000	-	$3,000
Travel	$1,500	-	$1,500
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$29,500**	**$25,000**	**$54,500**

JCU Project 1.1.1 Budget 2009/10

Item	MTSRF Funds	JCU In kind	Total Cost
Salaries	$28,000	$33,475	$61,475
Operating	$1,500	-	$1,500
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$35,140	$35,140
Total	**$29,500**	**$68,615**	**$98,115**

PROGRAM 1: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE GREAT BARRIER REEF

Project 1.1.2: Condition and trend of the GBR ecosystem: indicators, thresholds of potential concern, and ecological influence of GBR Zoning Plan on mid and outer shelf reefs

Project Leaders and Host Organisations

Dr Hugh Sweatman, Australian Institute of Marine Science
Dr Marie-Lise Schläppy, Reef Check Australia

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Hugh Sweatman	AIMS	Task Leader	0.3
AIMS Long Term Monitoring Team	AIMS	Reef Ecologists	4.2
Dr Marie-Lise Schläppy	RCA	Task Leader	0.2

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
AMPTO	Col McKenzie
Queensland Canegrowers	Matt Kealley
GBRMPA	Laurence McCook, David Wachenfeld, Roger Beeden
WWF	Ghislaine Llewellyn, Martin Taylor

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

In 2009/10 this project will measure the influence of the GBR Zoning Plan (2003) upon reef biodiversity. The program will provide an early warning of any new wave of crown of thorns starfish (COTS) outbreaks to allow the GBR tourism industry to prepare tactical responses. The project will also deliver regular reports on the broad-scale status and relative health of coral reefs in the GBR including information about regional and global resilience to natural disturbances (e.g. cyclones, crown-of-thorns starfish, coral disease and coral bleaching). These reports of condition and response will be linked with research in other MTSRF Programs, notably those for water quality and climate change, and will feed into the Integrated Reporting processes for the MTSRF and support community-based monitoring of tourism intensive sites in order to foster the concept of local environmental stewardship.

Key objectives:

(a) Surveys of coral reef health including the development of indicators and thresholds of concern for reef health [AIMS].

(b) Broad-scale surveys to examine the influence of the GBR Zoning Plan (2003) upon coral reef biodiversity [AIMS].

(c) Conduct surveys for crown-of-thorns starfish in the region of outbreak initiation – COTS Alert early warning of new outbreaks of starfish [AIMS].

(d) Conduct community monitoring of GBR coral reefs [Reef Check].

Project / Task Methodology

Objective (a): Broad-scale surveys of coral reef health including development of indicators and thresholds of concern for reef health

AIMS LTMP (Long Term Monitoring Program) has made annual surveys of approximately 100 coral reefs for fifteen years. Although this is a small sample of the ~3,000 reefs that make up the GBR, the survey reefs are widely distributed by latitude and longitude and cover all major sectors of the GBRMP. The annual surveys follow standard operating procedures (available on the AIMS website) and consist of a mixture of fine- and coarse-scale surveys. The fine-scale surveys conducted by SCUBA divers revisiting fixed transects provide detailed repeated measures of quantitative indicators of reef health; notably coral cover and composition, reef fish diversity and abundance, and periodically outbreaks of coral disease and/or coral bleaching. The coarse-scale monitoring achieved by towing snorkel divers around the entire perimeters of all reefs is particularly designed for detecting large disturbances like pest outbreaks (e.g. crown-of-thorns starfish), coral bleaching and cyclone damage to reef coral communities provides a broader picture that can augment the fine scale surveys.

Annual coverage of the entire GBR is accomplished by five to six voyages using AIMS vessels. Results from the broad-scale surveys are posted within a month of the end of each voyage. Results from the fine-scale surveys are also posted to the website once the coral data are extracted from the permanent digital records captured by the field teams. While all results are made available on the Internet as soon as they become available, the LTMP has produced major Status Reports at regular intervals.

In line with the alternation of survey tasks in alternate years, field work in 2009/10 will be directed towards objectives (b) and (c). However, the reporting regime described above pre-dates the concept of the e-Atlas as a central repository for information about the GBR. 2009/10 will see closer alignment of reporting to integrate the LTMP Reef Pages and “Reef Issues” pages (concerning COTS, bleaching, etc) into the e-Atlas framework.

Objective (b): Influence of the GBR Zoning Plan (2003) upon biodiversity of mid and outer shelf coral reefs

In the first year of MTSRF (2005/06), the AIMS LTMP realigned its sampling plan to assess the performance of the 2004 re-zoning plan for the GBR marine park in terms of protecting biodiversity. The new sampling plan consisted of comparisons between six pairs of matched reefs (similar size, complexity, cross-shelf position, exposure, etc.) in each of four regional clusters between Yeppoon and Cairns plus an additional four pairs in the Capricorn-Bunker group of reefs off Gladstone. One of the reefs in each pair was rezoned in 2004 from blue to green (i.e. from fished to ‘no-take’ category). The other was a similar reef in terms of size, distance from shore, exposure and morphology that remained open to fishing. These reefs were surveyed with the standard protocols used by the LTMP for its broad-scale surveys. Preliminary results for the primary target species, coral trout, showed an effect of protection only 18-22 months after the rezoning; complementing similar surveys of inshore sites by researchers from James Cook University (see also Russ *et al.* 2008).

Following the strategy of alternating broad-scale assessments of reef health (Objective (a)) with the assessments of zoning performance (Objective (b)) in successive years, the reef pairs selected for assessing the effects of rezoning will be re-surveyed in 2009/10 to provide

biodiversity assessments 1-2, 3-4, and 5-6 years after the rezoning in July 2004. This will close an important gap in our understanding of the time-scales of changes in biodiversity and other ecological responses to spatial closures ('no-take' zones). Unlike previous blue-green comparisons, which have concentrated on the populations of line-caught fishes, this task will also measure biodiversity across a spectrum of taxa in order to follow potential trophic cascades. This is important because, while it is not surprising that the target populations respond to change in fishing mortality, the overall objective of the new zoning plan was to conserve biodiversity applying the principles of comprehensiveness, adequacy and representativeness. This clearly involves indirect, ecosystem effects such as changes in the abundance of small species of fish, changes in the rates of herbivory, and changes in the dynamics of coral assemblages.

Objective (c): COTS-alert – Crown-of-thorns starfish early warning surveys

Marine park tourism operators have a particular interest in crown-of-thorns starfish outbreaks. These occur in waves that appear to be initiated in the area between Cairns and Cooktown. The last three waves have occurred at approximately fifteen-year intervals, with the last being detected in 1992, suggesting that another is due. The LTMP conducted special surveys of COTS populations on 41 reefs in the source area in 2006/07 and found no evidence a build up in adult starfish densities that might produce secondary outbreaks, but numbers of reefs to the north of Cooktown where starfish were recorded increased in the more recent 2008/09 surveys, though no outbreak populations were recorded. In view of the seriousness of the threat, reefs in the region will be surveyed again in 2009/10.

Objective (d): Community monitoring of GBR coral reefs

Reef Check Australia (RCA) is one node of an international marine conservation NGO that operates in ninety countries. RCA trains and supports volunteers to conduct community-based assessments of the condition and trend of coral reefs and has a strong international outreach program. In the GBR, RCA has established strong partnerships with marine park tourism operators who provide logistic support for Reef Check volunteers to visit their operations in exchange for status reports on the condition of reef resources. Over the life of the MTSRF, Reef Check proposes to train additional volunteers (bringing the total to around fifty) and to coordinate community monitoring and reporting of the status and trends of 25 key dive tourism sites. Through regular visitation, this program is able to resolve temporal (seasonal and inter-annual) patterns of change in biodiversity and more closely observe emerging phenomena such as outbreaks of pests and disease. RCA surveys augment long-term monitoring surveys by increasing the number of sites, particularly sites important for dive tourism, and the number of target species surveyed and recording the abundance of rare biota such as clams and large fish as they are not restricted to fixed transects. RCA will communicate MTSRF outcomes from its own and other programs through its volunteer "message-carriers" and its established communication channels that include online scientific and lay reports, brochures, and community education events/public forums. Data and information obtained from Reef Check surveys funded by the MTSRF programme have also been contributed to the e-Atlas. All information and capacity will be shared as best practice with the international Reef Check network of ninety countries.

Project Outputs/Outcomes

Objective (a): The continued surveys by the AIMS LTMP have provided a very significant source of data describing the condition of the GBR. These data have made a significant contribution to the GBRMPA Outlook Report and the expansion of the e-Atlas, and in addition, have been the basis for numerous publications relating to indicators of reef health under MTSRF Project 1.1.1, and several significant publications with direct relevance to

management of the GBR (e.g. Sweatman 2008[§], Bruno *et al.* 2009[**]). Further integration of reporting into the e-Atlas framework will continue the process of making information from LTMP surveys broadly accessible in a relevant form.

Objective (b): The rezoning of the GBRWHA in 2004 was an environmentally, economically and socially significant undertaking by the GBRMPA. In order to assess the success of the re-zoning plan in achieving its primary goals of conservation and sustainable use of biodiversity within the GBRWHA, several MTSRF funded projects are examining different environmental and social aspects of the performance of the 2004 re-zoning plan. Work conducted under this objective and within Project 4.8.2 demonstrated a rapid increase in the biomass and density of fisheries target species, particularly coral trout, in reef areas protected under the rezoning from fishing (Russ *et al.* 2008[††]). These results were widely publicized and emphasised in the GBRMPA Outlook Report. Since the new GBR zoning plan is not specifically focused on fisheries, but aims to conserve the overall biodiversity of the GBR, surveys conducted under this objective have also collected data on numerous other taxa in order to assess the ecosystem effects of protection on other important components of the biodiversity of the GBRWHA. These include processes such as trophic cascades involving prey species (and possibly their prey) and even less direct effects such as higher coral recruitment (reported in Mumby *et al.* 2007[‡‡] in the Caribbean). The highly variable recruitment of marine organisms and patchy disturbance regimes mean that these effects may not be immediately apparent but should become more evident over time. Surveys of the reef-pairs in 2009/10 aim to track the development of such effects.

Objective (c): In the late 1990s when the last wave of outbreaks of the crown-of-thorns starfish (*Acanthaster planci*) passed through the Cairns region, Tourism operators spent significant sums of money using divers to protect the reef around tourism facilities such as pontoons. The COTS-alert surveys aim to give advance warning of any new wave, to allow the tourism industry to plan and finance a response. The suggestion from surveys under the project in 2008/09 that starfish numbers are increasing on reefs north of Cooktown needs to be confirmed or negated by further surveys this year under this proposal.

Objective (d): The coral reef surveys conducted RCA for the last three years generated data on the condition of reefs on 25 sites of importance to the dive industry on the GBR. No significant change in biodiversity or outbreaks of pests and disease were observed. The data have been made available to tourist operators, the general public, managers and scientists through the RCA database and the e-Atlas and will be published in the future. Communication materials such as a brochure, DVD and laminated booklet were produced and given to dive operators to promote the stewardship, understanding and good management of coral reefs.

[§] Sweatman, H. (2008) No-take reserves protect coral reefs from predatory starfish. *Current Biology* 18: R1-R2.

[**] Bruno, J. *et al.* (2009) Assessing evidence of phase shifts from coral to macroalgal dominance on coral reefs. *Ecology* 90: 1478-1484.

[††] Russ, G. R. *et al.* (2008) Rapid increase in fish numbers follows creation of world's largest marine reserve network. *Current Biology* 18: R514-R515.

[‡‡] Mumby, P. J. *et al.* (2007) Tropic cascade facilitates coral recruitment in a marine reserve. *PNAS* 104: 8362-8367.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
a	No field work component in 2009/10	-
	Integration of LTMP reef pages and Reef Issues pages into the e-Atlas	Jun 2010
b	40% of Rezoning monitoring reefs to be completed (weather permitting)	Dec 2009
	Report summarizing findings for surveys of rezoning reefs to date	Apr 2010
	Fieldwork completed; preliminary summaries posted on-line within one month of voyage completion (www.aims.gov.au) and delivered to the e-Atlas.	Jun 2010
c	COTS early warning surveys planned for 2009/10	Mar 2010
d	Reef Check Surveys: a) Survey 18 key tourism sites and submit report describing the condition these sites. b) Train 10 new community volunteers to join current RCA survey teams. c) e-Atlas linked to RCA survey database	Jun 2010
	Dive Industry Workshops/Meetings a) Feedback from operators to suggest improvements to survey database reporting function b) Promotional poster printed	Dec 2009
	Extensive communication through quarterly newsletters, web updates	Jun 2010
	Report on Reef Check training	Jun 2010

Project 1.1.2 Milestone Payments 2009/10

For 2009/10 outputs only		Payments	
Milestones	**Date**	**AIMS**	**RCA**
Signing of contract		$60,000	$16,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 (with appropriate attribution of MTSRF funding) [AIMS]: • Progress update for objective (b): preliminary findings, delivery of on-line regional assessments for voyages to date • Schedule of proposed fieldwork for areas still to be surveyed. • Schedule and plan for integration of components of LTMP reporting with e-Atlas	13 Nov 2009	$80,000	-
Report 2 (with appropriate attribution of MTSRF funding) [RCA]: • Operators feedback acquired about database reports • Poster design	10 Dec 2009	-	$14,000
Report 3 (with appropriate attribution of MTSRF funding) [AIMS]: • Report on findings of COTS Alert surveys [AIMS]	15 Feb 2010	$40,000	-
Report 4: Progress report (with appropriate attribution of MTSRF funding): [RCA]: • Data made available to the e-Atlas • Report on RCA training	10 Mar 2010	-	$14,000
Report 5 (with appropriate attribution of MTSRF funding) [AIMS]: • Preliminary report summarising findings from recent rezoning surveys completed so far (objective (b)).	16 Apr 2010	-	-
Report 6 (with appropriate attribution of MTSRF funding): • Report on areas surveyed for objective (b) including a summary of salient results for rezoning surveys undertaken in 09/10 and comparison with past findings [a, AIMS] • Report on integration of LTMP reporting with e-Atlas [a, AIMS] • Final report on the results of RCA surveys conducted at each site over the MTSRF period [Reef Check] • Meta-data uploaded to the e-Atlas [AIMS, Reef Check]	15 June 2009	$86,000	$6,000
MTSRF Funding*		**$266,000**	**$50,000**

* Total excludes funds held for Visual Documentation.

Project 1.1.2 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$316,000	-	$316,000
MTSRF Visual Documentation*	$4,000	-	$4,000
AIMS (a, b)	-	$600,000	$600,000
AMPTO (d)	-	$5,000	$5,000
Total	**$320,000**	**$605,000**	**$925,000**

* A total of $4,000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

AIMS Project 1.1.2 Budget 2009/10

Item	MTSRF	In-kind	Total Cost
Salaries	$266,000	$300,000	$566,000
Operating	-	$300,000	$300,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$266,000**	**$600,000**	**$866,000**

Reef Check Australia Project 1.1.2 Budget 2009/10

Item	MTSRF Funds	In-kind	Total Cost
Salaries	$35,000	-	$35,000
Operating	$5,000	$5,000	$10,000
Travel	$5,000	-	$5,000
Communication / Extension	$5,000	-	$5,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$50,000**	**$5,000**	**$55,000**

PROGRAM 1: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE GREAT BARRIER REEF

Project 1.1.3: Condition, trend and risk in coastal habitats: Seagrass indicators, distribution and thresholds of potential concern

Project Leaders and Host Organisations

Associate Professor Michelle Waycott, James Cook University – Objectives (b) and (c)
Dr Len McKenzie, Queensland Department of Employment, Economic Development and Innovation – Objective (a)

Project 1.1.3 has three major objectives:

(a) Status and trend of GBR seagrasses (community monitoring): Seagrass-Watch.
(b) Understanding the drivers of seagrass change, indicators of seagrass health and thresholds of potential concern.
(c) Risk assessment for coastal seagrass habitats: values, threats and vulnerabilities.

Aspects of the project that relate to the delivery of Objective (a) are to be led by Queensland Primary Industries and Fisheries (DEEDI). Aspects of the project that relate to the delivery of Objectives (b) and (c) are to be led by James Cook University.

Project Team 2009/10

Title	Organisation	Role	FTE*
A Prof Michelle Waycott	JCU	Task leader (b) and overall project Task collaborator (all tasks)	0.20
Mr Len McKenzie	QPIF (DEEDI)	Task leader (a) Task collaborator (all tasks)	0.5
Ms. Alana Grech	JCU/ QPIF (DEEDI)	Task leader (c)	0.25
Dr Catherine Collier	JCU	Postdoctoral Researcher (b)	1.0
A Prof Joseph Holtum	JCU	Task collaborator (b)	0.05
Dr Rob Coles	QPIF (DEEDI)	Task collaborator (c)	0.2
Dr Korjent Van Dijk	JCU	Task collaborator	0.2
Dr Michael Rasheed	QPIF (DEEDI)	Task collaborator (c)	0.1
Dr Jane Mellors	QPIF (DEEDI)	Task collaborator (a, b, c)	0.3
Mr Rudi Yoshida	QPIF (DEEDI)	Technician – (a, b)	0.6

* FTE from all sources including associated third party projects, in-kind and MTSRF.

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
QPIF (DEEDI)	John Beumer
AMPTO	Col McKenzie
GBRMPA	Laurence McCook
DEWHA	Kevin Gale
WWF	Piet Filet

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Description of Project / Task Objectives

The components below will deliver cost effective research and assessment of the region's seagrasses including assessment of the threats from human impacts to be coupled against findings from Objective (a) of this Project (1.1.3) to improve knowledge of the distribution of seagrass habitats. The project has strong links to the threatened species theme as these seagrass habitats provide a key food resource for the nationally threatened species of marine turtles and dugong. Outputs of the project will have a strong spatial component including production of GIS layers. A research objective (partly experimental and recommended by the MTSRF Great Barrier Reef Steering Committee) to generate a better understanding of the drivers of seagrass change is included in the information presented here.

The fifteen species of seagrasses occurring in the GBR can be found in estuaries/inlets, along coasts, in lagoons and reef platforms growing in intertidal, subtidal, and deep-water environments (Carruthers *et al.* 2002). The greatest meadow area is found in estuarine and coastal waters and these are the most at risk from both point and diffuse sources of human-related impacts (Carruthers *et al.* 2002). Although gaps in our knowledge of seagrass distribution do still remain, these distributions have been relatively well described. These mapping efforts, combined with ongoing community engagement and monitoring (Seagrass-Watch), focus of Objective (a) of this project) have highlighted that seagrass meadows are ephemeral; they come and go on time-scales of months to years (www.seagrasswatch.org; Coles *et al.* 2007; Waycott *et al.* 2005). In other regions, fluctuations in seagrass distribution and biomass have been observed with seasonal fluctuations in temperature, light and nutrient availability (Alcoverro *et al.* 1997; Dunton 1994; Moore *et al.* 1997; Perez 1992). However, the interrelationship between human mediated influences and normal population changes in seagrass distribution in the GBR are poorly understood (e.g. Inglis 2000). The objectives described here will address questions that will enhance our understanding.

Project / Task Methodology

Objective (a): Status and trend of GBR seagrasses: community monitoring

This task will build and continue support of the established technical/scientific core of the intertidal seagrass assessment program (Seagrass-Watch), which has a significant community engagement component. This is a cost effective program employing the skills of scientists and utilising community resources. The program has expanded rapidly across Queensland and interest is high within the GBRWHA to initiate additional long term assessment sites in many other areas (e.g. Cardwell and North of Cooktown) to improve knowledge of the distribution of biota and their associated habitats within the region. This

task is essential to continue support of not only the existing 28 sites of the GBR Reef Rescue Marine Monitoring Program but also the larger geographic spread of sites (currently 122) including those in Dugong Protected Areas and other areas of community interest. Seagrass-Watch is also one of the most detailed datasets currently available on which several research programs/investigations (including objective b) are based.

Objective (b): Understanding the drivers of seagrass change

Historically, seagrass habitats of the GBR would have been characterised by having low nutrient availability and being primarily nitrogen limited (Udy *et al.* 1999). Since European settlement, human activities in the catchments and coastal zones have greatly increased turbidity and nutrient concentrations and many coastal seagrass habitats are now characterised by low light availability (Carruthers *et al.* 2002). These meadows are threatened by chronic reductions in water quality as well as physical disturbance from storms, floods, swell and human activities and acute short-term water quality reductions associated with flood events and coastal construction associated with urbanisation (e.g. marina's) and changing land use patterns (e.g. bridges, stream flow). Climate change predictions also indicate that seagrasses will face rising sea temperatures and in shallow intertidal meadows, localised intense increases in temperature could lead to seagrass burn-off (Waycott *et al.* 2007). These climate change predictions also indicate that increased storm intensity and wind speeds could exacerbate the impacts of low light availability. For these reasons, light and temperature are the drivers proposed for further investigation in the current proposal.

Strategies adopted by environmental managers to mitigate the impacts of human activities on seagrass meadows are largely based on information taken from other well studied areas, such as the northern hemisphere or Australian temperate meadows. In developing our understanding of the drivers of seagrass meadows, we will identify threshold levels of change that limit the biomass, growth and reproductive capacity of coastal seagrasses. These outcomes will provide management authorities with experimentally based targets that can be applied during monitoring programs to enforce management actions, i.e. triggers.

Existing projects can contribute to the outcomes of this work. Recent workshops (MTSRF and RWQMP) and publications (Johnson and Marshall 2007[§§]) have identified these studies as priorities. The Water Quality Monitoring component of GBRMPA's Marine Monitoring Program includes detailed sediment and seagrass tissue nutrient analysis, *in situ* temperature data, biomass and seed density at sites throughout the GBR (Schaffelke 2006). This supporting information will considerably strengthen the proposed field and experimental work by providing long-term and historical data sets. Seagrass species that dominate in coastal and estuarine waters (*Halophila*, *Halodule*, *Zostera*, *Cymodocea*) will be the focus of the work, as these meadows are the most vulnerable to changes in temperature and light availability.

Objective (c): Risk assessment for coastal seagrass habitats: values, threats and vulnerabilities.

Coastal and deepwater seagrass are threatened by various anthropogenic activities such as coastal runoff and other impacts. Regulatory decisions to manage these activities are typically made with incomplete scientific information. However, a good management decision rule should not require large numbers of precise estimates to trigger warranted management actions. The risks to seagrasses need to be assessed using the best available data in the face of the high social, economic and political costs of eliminating the environmental effects of human activities and the ecological consequences of postponing

[§§] Johnson, J. E. and Marshall, P. A. (eds.) (2007) *Climate Change and the Great Barrier Reef*. Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia.

action. Decision-support tools, such as spatial risk assessments in geographical information systems (GIS), can assist in rapid assessments of risks to seagrass by incorporating spatially explicit models of species distribution with qualitative and quantitative information on the distribution of resources and anthropogenic impacts. A spatial risk assessment approach, therefore, enables management efforts to be targeted to areas identified by the assessment as requiring action.

Currently, there is limited information on risk to seagrasses from anthropogenic activities across various areas of the GBRWHA. We will evaluate the risks to seagrasses based on modeling of changes in seagrass distribution under different ecosystem stress scenarios. Our approach will utilise current data available through various broad scale mapping and monitoring schemes to evaluate risks to seagrasses across a range of GBR regions. Further work to refine models to encompass more functional models of seagrass habitat associated with different community structures and ecosystem service values is planned once baseline models are evaluated.

Project 1.1.3 Targeted Activities

Objective	Targeted Activity	Completion Date
(a)	A 1. Undertake Seagrass-Watch community monitoring for intertidal seagrass abundance, community structure, distribution, physical parameters at agreed regularly monitored sites throughout the GBRMP.	1 Dec 2009
(a)	A 2. Undertake Seagrass-Watch community monitoring for intertidal seagrass abundance, community structure, distribution, physical parameters at agreed regularly monitored sites throughout the GBRMP.	28 May 2010
(a)	A 3. Seagrass-Watch newsletter completed every 4-6 months from 1 July 2009 (min. two for year ending June 2010).	1 ea. at minimum of 30 Nov 09, 31 May 10
(b)	B 1. Test seagrass responses to drivers of seagrass change through field data collection.	1 Dec 2009
(b)	B 2. Conduct mesocosm experiments investigating the interactive effects of temperature and light on seagrass growth.	10 Jun 2010
(b)	B 3. Analyse and report *in-situ* light and temperature measurements at seagrass monitoring sites in objective (a).	10 Jun 2010
(c)	C 1. Review the GBRWHA risk assessment model of seagrass habitat.	1 Dec 2009
(c)	C 2. Working group convened to re-assess applicability of the GBR seagrass habitat risk assessment model	1 March 2010
(c)	C 3. Refine model output for the GBRWHA	1 May 2010

Project 1.1.3 Milestones 2009/10

For 2009/10 outputs only		Payments	
Milestones	**Date**	**JCU**	**QPIF**
Signing of contract		$25,000	$23,000
Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission QPIF (DEEDI) (with appropriate attribution of MTSRF Funding): • Report on Seagrass-Watch intertidal: locations, abundance, community structure and distribution at agreed sites (newsletter) (obj a) • Plan of any communication products/events for Year 4 and summary of any communication activities undertaken to date, including minutes of meetings/workshops as applicable (obj a) **Report 1 submission JCU (with appropriate attribution of MTSRF Funding) describing:** • Experimental results from initial mesocosm experiments (b2) • Summary of data outputs from light loggers at field sites (b3) • Evaluation of the effectiveness of the GBR risk assessment (c1) • Plan of any communication products/events for Year 4 and summary of any communication activities undertaken to date, including minutes of meetings/workshops as applicable (b) and (c)	1 Dec 2009	$26,000	$24,000
Report 2 submission QPIF (DEEDI) (with appropriate attribution of MTSRF Funding): • Findings of Seagrass-Watch intertidal: locations, abundance, community structure and distribution at agreed sites (newsletter) (a) • Assist with maintenance of light loggers at selected field sites (b3) • Host, attend and assist in the organization of working group meetings to re-asses and refine the risk assessment (c) **Report 2 submission JCU (with appropriate attribution of MTSRF Funding):** • Progress report on experimental work and refinement of spatial risk assessments via working group activities (b and c) • Meta-data describing the data generated by the project lodged on the e-Atlas (objectives a, b, c)	28 May 2010	$25,000	$23,000

For 2009/10 outputs only		Payments	
Milestones	**Date**	**JCU**	**QPIF**
Report 3 submission QPIF (DEEDI) (with appropriate attribution of MTSRF Funding): • Summary report on findings from Seagrass-Watch monitoring to date at agreed sites (a) • Final summary describing communication and collaboration activities completed to date (a) **Report 3 submission JCU (with appropriate attribution of MTSRF Funding):** • Final report describing the results and analysis of mesocosm experiments investigating the interactive effects of temperature and light on seagrass growth (b2) • Final report describing the results of in situ light and temperature measurements at seagrass monitoring sites (b3) • Final report of outputs from risk assessment working group activities and refined model output for the GBRWHA (c2, c3) • Final summary describing communication and collaboration activities completed to date (b and c)	1 June 2010	$26,000	$25,000
Total MTSRF Funding		**$102,000**	**$95,000**

* Total excludes $3,000 for Visual Documentation Allocation, but includes $2,000 to support collaboration.

Year 4 – 2009/10 Project Funding and Partnerships

Total payment summary	JCU	QPIF (DEEDI)	Total
MTSRF funds*	$102,000	$95,000	$197,000
In-kind	$194,689	$158,308	$352,997
Total	**$296,689**	**$253,308**	**$549,997**

* Total excludes $3,000 for Visual Documentation Allocation.

Project 1.1.3 Budget 2009/10

Contributing Organisation	Cash	In-kind	Total
MTSRF specifically against research objective (a)	$50,000	-	$50,000
MTSRF specifically against research objective (b)	$125,000	-	$125,000
MTSRF specifically against research objective (c)	$20,000	-	$20,000
MTSRF to support collaboration	$2,000	-	$2,000
MTSRF Visual Documentation*	$3,000	-	$3,000
JCU	-	$194,689	$194,689
QPIF	-	$158,308	$158,308
Total	**$200,000**	**$352,997**	**$552,997**

* A total of $3,000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

QPIF (DEEDI) Collaboration with JCU for all objectives of Project 1.1.3 Budget 2009/10

Item	MTSRF Funds	In-kind and third party contracts	Total Cost
Salaries	-	-	-
Operating	-	-	-
Travel	$2,000	-	$2,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$2,000**	**-**	**$2,000**

JCU Objective (a) Project 1.1.3 Budget 2009/10

Item	MTSRF Funds	In-kind and third party contracts	Total Cost
Salaries	-	$6,695	$6,695
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$7,028	$7,028
Total	**-**	**$13,723**	**$13,723**

QPIF (DEEDI) Objective (a) Project 1.1.3 Budget 2009/10

Item	MTSRF Funds	In-kind and third party contracts	Total Cost
Salaries	$44,000	$44,631	$88,631
Operating	$3,000	-	$3,000
Travel	$3,000	-	$3,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$49,711	$49,711
Total	**$50,000**	**$94,342**	**$144,342**

JCU component of Objective (b) Project 1.1.3 Budget 2009/10

Item	MTSRF Funds	In-kind and third party contracts	Total Cost
Salaries	$82,000	$62,828	$144,828
Operating	$13,000	$7,000	$20,000
Travel	$5,000	$4,000	$9,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$65,969	$65,969
Total	**$100,000**	**$139,797**	**$239,797**

QPIF (DEEDI) component of Objective (b) Project 1.1.3 Budget 2009/10

Item	MTSRF Funds	In-kind and third party contracts	Total Cost
Salaries	$15,000	$5,030	$20,030
Operating	$6,000	-	$6,000
Travel	$4,000	-	$4,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$5,602	$5,602
Total	**$25,000**	**$10,632**	**$35,632**

JCU component of Objective (c) Project 1.1.3 Budget 2009/10

Item	MTSRF Funds	In-kind and third party contracts	Total Cost
Salaries	-	$20,085	$6,695
Operating	$1,000	-	$1,000
Travel	$1,000	-	$1,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$21,084	$7,028
Total	**$2,000**	**$41,169**	**$15,723**

QPIF (DEEDI) component of Objective (c) Project 1.1.3 Budget 2009/10

Item	MTSRF Funds	In-kind and third party contracts	Total Cost
Salaries	$10,000	$25,231	$35,231
Operating	$8,000	-	$8,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$28,103	$28,103
Total	**$18,000**	**$53,334**	**$71,334**

PROGRAM 1: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE GREAT BARRIER REEF

Project 1.1.4: Dating and mapping historical changes in GBR coral communities

Project Leader and Host Organisation

Associate Professor Jian-xin Zhao, The University of Queensland

Project Team 2009/10

Title	Organisation	Role	FTE
Assoc. Professor Jian-Xin Zhao	UQ	Project Leader	0.2
Professor John Pandolfi	UQ	Co-investigator	0.2
Dr Terry Done	AIMS	Co-investigator	0.1
Dr. Kefu Yu (ARC Research Fellow)	UQ	Co-investigator	0.1
PhD student (geochronology) – Miss Tara Clark	UQ	Co-investigator	1.0
PhD student (mainly ecology) - Mr George Roff	UQ	Co-investigator	1.0
PhD student (mainly cyclone history) - Mr Alberto Rodriguez	UQ	Co-investigator	0.5

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
DEWHA	Kevin Gale
AMPTO	Col McKenzie
Queensland Canegrowers	Matt Kealley
GBRMPA	Laurence McCook
WWF	Nick Heath

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

A large number of dead branching corals and massive coral heads, representing individual life spans up to hundreds of years, exist among the coral communities of coastal reefs. Modern dating methods using the TIMS Uranium-series allow us to know the age of dead coral colonies *in situ* on the GBR at a resolution of 1-3 years over several hundred years of history. This allows temporal bracketing of significant mortality events back to the time of early European settlement of Queensland and beyond. Knowledge of the age structure of the death assemblages can be related to major human developmental events and recent mass bleaching events related to global warming, so that the sources of the mortality can be identified; management can be directed toward ameliorating those sources. If the coral mortality has resulted in substantial changes in reef coral community structure, then management is in a position to understand what the previous state of the reef was, so we

can overcome the 'shifting baseline syndrome' whereby each new generation of managers and scientists has a different view of what constitutes 'natural'. GBRMPA has already invested in this historical perspective through its 'Historical Photographs' initiative, and we intend to expand this perspective to inform the Authority about the natural state of the coral reef.

Project 1.1.4 has seven main objectives:

(a) Refining a specially designed sample preparation and analytical protocol to improve the precision and accuracy of U-series dates of the death assemblages.
(b) Determine the decadal death rate of both massive and branching corals over the last 200 years (since European settlement).
(c) Determine the variation in coral community structure over the past 200 years.
(d) Correlate rates of coral mortality with major human development and recent El Niño events.
(e) Reconstruct coral mortality rates and community change over the past millennium leading up to European settlement using short cores from back reef environment.
(f) Reconstruct cyclone history and frequency over the past millennium through precise dating of transported reef blocks and lagoon sediment cores.
(g) Distinguish the impact of human developmental events and anthropogenically-induced global warming from natural variability.

Project / Task Methodology

Objective (a): Determine the decadal death rate of massive and branching corals over the last 200 years (since European settlement)

The first question that we address is whether there has been any change in the decadal death rate of nearshore GBR corals over the last two hundred years. An abundance of large massive coral heads spanning multiple centuries now characterises the coral communities of nearshore GBR reefs. Are these communities similar in community structure to ones from hundreds to thousands of years ago? Or have the massive corals survived the longest, whilst large-scale mortality of branching acroporid species has occurred? In northern areas of the GBR such as Princes Charlotte Bay, nearshore reefs have abundant and diverse branching coral communities along with their large massive counterparts; in many parts of the central and southern GBR only the massive corals are conspicuous. Our U-Th dating of surface branching coral rubbles from inshore reefs of Mackay in southern GBR shows that 15 of the 25 samples dated between 1750 to 1930 AD, whereas the remaining 10 samples died either prior to 1811 AD (4 samples) or after 1963 AD (6 samples) (Quaintance, 2006, Honour's thesis, UQ; Clark et al., unpublished). In a separate study, we dated 28 branching coral rubbles from three transects on Pelorus Reef in central GBR. The results, again, show a long-term decline of previously dominant acroporoid corals since the onset of European settlement.

Objective (b): Determine the variation in coral community structure over the past 200 years

The second question that we will address is whether there has been any change in coral community structure in nearshore GBR coral reefs since European settlement. Methodologies for addressing this question have been well-developed by John Pandolfi and his team (Pandolfi *et al*., 2003, *Science*) and their work was highly influential in convincing GBRMPA and the government in 2004 to make an historic, landmark decision to re-design their zoning plan by setting aside > 35% of the Great Barrier Reef as no-take areas. Our results from Keswick and Pelorus Reefs show that community structure of the death

assemblages in the sites dominated by dead coral rubbles with low coral cover is significantly different from sites where live corals are dominant.

Objective (c): Correlate coral mortality ages with major human developmental and recent El Niño events

The third question we wish to answer is whether there are any correlations between coral mortality ages (or age population distribution of branching coral rubbles) and major human developmental and El Niño events over the past two hundred years. In our previous studies, we have demonstrated that massive *Porites* corals in the southern South China Sea (within the SW Pacific Warm Pool) died many times over the past two centuries, most correlated precisely with historic El Niño events (Yu *et al.* 2006). We expect that a similar phenomenon may be present in the GBR. For instance, we have dated one dead *Porites* colony on Magnetic Island which shows the coral died in 1983±2 AD, probably in response to the 1982-1983 AD El Niño. The ages of many dated pieces of coral rubble appear to cluster in groups that may be related to major events. Dating of dead massive corals also show the mortality ages appear to cluster in groups.

In order to achieve this objective, we have sampled a latitudinal gradient from Mackay and Townsville regions in the south (high-impact regions) to Douglas Islet (11°14.281′S; 142°59.397′E), Wizard Reef (11°31.448′S; 143°00.703′E), Clerke Island (11°58.350′S; 143°16.988′E) and Haggerstone Island (12°02.500′S; 143°17.587′E) to the north (more pristine low-impact region). We expect to complete the dating of collected samples during the final year.

In addition to sampling across a latitudinal gradient, we plan to sample several key sites along an increasing water quality gradient from both the Townsville and/or Mackay regions, to enable us to examine the discordance between living and death assemblages as evidence for anthropogenic ecological change, and to assess the impact of river runoffs on reef health. Samples along a water quality gradient transect are already available in the Mackay region. Later this year, we plan to sample across another water quality gradient transect in the Townsville region.

Objective (d): Reconstruct coral mortality rates and community change over the past millennium leading up to European settlement using short cores from back reef environment

The fourth question we wish to address is whether there has been any change in coral community structure in nearshore GBR coral reefs over the past millennium leading up to European settlement. To answer this question, we have collected forty cores (2-5 metres) from the back reef environment of Pandora and Havannah Reefs (central GBR). Precise dating of over 120 coral fragments found within the cores enable us to establish detailed chronological framework, with more dating still in progress. The results reveal surprisingly high accretion rates (4 times greater than expected), implying prolific coral growth in such environment whereas the space in reef flat areas has been fully occupied. Preliminary analyses of cores reflect some interesting changes in the community structure, which could be related to natural causes such as cyclones.

Objective (e): Reconstruct cyclone history and frequency over the past millennium through precise dating of transported reef blocks and lagoon sediment cores

This part of the project aims to use natural archives to reconstruct extreme wave events (mainly tropical cyclones, but may have tsunamis) that impacted the Great Barrier Reef (GBR) over the past millennium and to distinguish recent anthropogenic trend in intensity and frequency from longer-term natural variability. This study will specifically focus on the establishment of a precise chronology for wave-transported coral blocks and lagoon

sediments from Heron/Wistari reefs, southern GBR and Trunk/Bramble reefs, central GBR, and the combined use of transported coral blocks and grain-size distributions of lagoon sediments for cyclone event reconstruction, which has been demonstrated in the PIs' previous studies in the South China Sea and Heron/Wistari reefs (Yu *et al.* 2004, 2008; Zhao *et al.* 2009).

Objective (f): Distinguish the impact of human development events and anthropogenically-induced global warming from natural variability

We plan to synthesis data collected for Objectives (a) to (e) to assess the extent of anthropogenic impact on coral mortality and community structure and separate this from that expected as part of a natural variability and trend. Only by removing that attributable to natural process can we confidently predict the trend in the near future under scenarios of global warming and increased coastal development.

Project Outputs/Outcomes

Over the past three years, the project has combined moderate MTSRF funding with substantial UQ commitment and AIMS ship support to undertake several major field investigations across a large latitudinal range from Heron/Wistari reefs in the south, through Mackay/Townsville regions, to several selected islands in the far-northern GBR. A large number of samples from coral rubbles, dead massive corals, cyclone-transported reef blocks and back-reef cores as well as underwater video footage were collected and over 200 U/Th dated. More samples, including surface rubbles, dead massive corals and lagoon cores will be collected, and over 150 U/Th dates will be determined in the fourth year (a new ARC-funded new-generation multi-collector ICP-MS will be installed by the end of this year to augment our capacity for U/Th dating).

To date, the major outcomes of the project have been:

- The establishment of a novel methodology using a world-first U-series analytical protocol for dating extremely young and often severely altered and contaminated coral rubble. This opens door to future more extensive and systematic investigation of historical changes in GBR coral communities using this methodology.
- U/Th dating of the death assemblages unequivocally suggest an increasing rate of coral mortality since European settlement, which appears to have reduced overall coral coverage and caused changes in the coral community structure within the studied areas.
- Both climatic and anthropogenic factors appear to have played some role in causing coral mortality in the GBR.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)-(f)	Field trip to Townsville region to sample across a water-quality-gradient	Dec 2009
(a)-(f)	Complete refinement of analytical protocol (including sample cleaning procedures and site-specific correction factors for U/Th dates of coral samples) and apply this protocol to re-date key samples to improve age precision	Dec 2009
(a)-(f)	Complete the dating of selected samples from target areas	May 2010
(a)-(f)	Synthesize analytical data for publication	June 2010
(a)-(f)	Submission of Mr Jez Roff's Ph.D thesis (Two PhD theses will be submitted after June 2010, because their 3-year candidature extends beyond this time)	Dec 2009

Project 1.1.4 Milestone Payments 2009/10

For 2009/10 outputs only	**Date**	**Payments**
Milestones		**UQ**
• Signing of contract		$20,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report 1 submission: • Plan for final fieldwork [UQ] • Update on further dating results [UQ] • Plan of communication outputs and products for Year 4 and summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable [UQ]	13 Nov 2009	$10,000
Report 2 submission: • Report on the outcome of Mr Jez Roff's PhD thesis [UQ] • Preliminary report (with appropriate attribution of MTSRF funding) on the outcomes of final fieldwork [UQ] • Synthesis of existing data for publication [UQ]	15 Feb 2010	$10,000
Report 3 submission: • Final report (with appropriate attribution of MTSRF funding) on analytical results, including a summary of major research outcomes achieved throughout the project, and recommendations for future work [UQ] • Meta-data describing all data generated by MTSRF Project 1.1.4 lodged on the e-Atlas	15 June 2010	$10,000
MTSRF Funding		**$50,000**

Project 1.1.4 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$50,000	-	$50,000
MTSRF Visual Documentation*	-	-	-
UQ	-	$278,000	$278,000
AIMS	-	-	-
	-	-	-
Total	**$50,000**	**$278,000**	**$328,000**

UQ Project 1.1.4 Budget 2009/10

Item	MTSRF	UQ – In Kind	Total Cost
Salaries	$15,000	$224,000	$239,000
Operating	$20,000	$50,000	$70,000
Travel	$12,000	$4,000	$16,000
Communication / Extension	$3,000	-	$3,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$50,000**	**$278,000**	**$328,000**

PROGRAM 1: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE GREAT BARRIER REEF

Project 1.1.5: Atlas of Australia's Tropical Lands and Seas (e-Atlas)

Project Leader and Host Organisation

Dr Katharina Fabricius, Australian Institute of Marine Science

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Katharina Fabricius	AIMS	Project leader, marine ecology, reporting, communication	0.2
Dr Glenn De'ath	AIMS	Statistical tools, spatial analyses	0.3
Dr Eric Lawrey	AIMS	Systems developer / programmer	1.0
Dr David Souter	RRRC	Project leader, marine ecology, reporting, communication	0.3*
Mark Rehbein	AIMS	Metadata and data management	0.05*

* In-kind contributions

Summary Table of Research Users

Organisation	Contact
DEWHA	Kevin Gale
DEWHA/ERIN	Mike Maslen
DEWHA/Marine	Travis Bover
GBRMPA	David Wachenfeld, Chris Briggs
QPIF	Malcolm Dunning
AMPTO	Col McKenzie
WWF	Nick Heath

Project Duration

Start Date: July 2007 End Date: 30 June 2010

Project / Task Objectives

Existing data and information on the Great Barrier Reef and the terrestrial tropical ecosystems has generally been under-used. The e-Atlas is developing the tools to make greater use of such data information. By providing the means to share and access data, maps and information on topics relevant to Australia's tropical land and seas, the e-Atlas aims to promote collaboration and support the work of management agencies, researchers, reef-based industries and community groups.

The objectives of the e-Atlas are to:

- Provide a 'one-stop shop' for accurate, up-to-date and comprehensive information, maps, reports, scientific papers and data;
- Produce interactive maps of environmental conditions, biodiversity, risks and hotspots of environmental concern;
- Provide high capacity storage, custom-developed open-source software for data processing and display as well as data access to the public and/or registered users;
- Provide the platform for data integration and collaboration across institutions; and
- Display the results of statistical and process models, to synthesise and interpret data and to inform management about contemporary ecological and environmental issues with an emphasis on risk, resilience and response.

The e-Atlas comprises four components:

1. A Website to host the data repository and tools and to provide interpretative text summaries of key topics;
2. A searchable Repository of data, metadata, maps and scientific reports;
3. Tools to search, explore, interactively map and analyse spatial and temporal data; and
4. Research into risk, resilience and response of the GBR system.

The technical and conceptual development of the tools that underpin the e-Atlas is progressing rapidly. The initial priority has been to develop the backbone of the system (web site, mapping, statistical tools, and automation of work flow; Figure 1) before populating it with content.

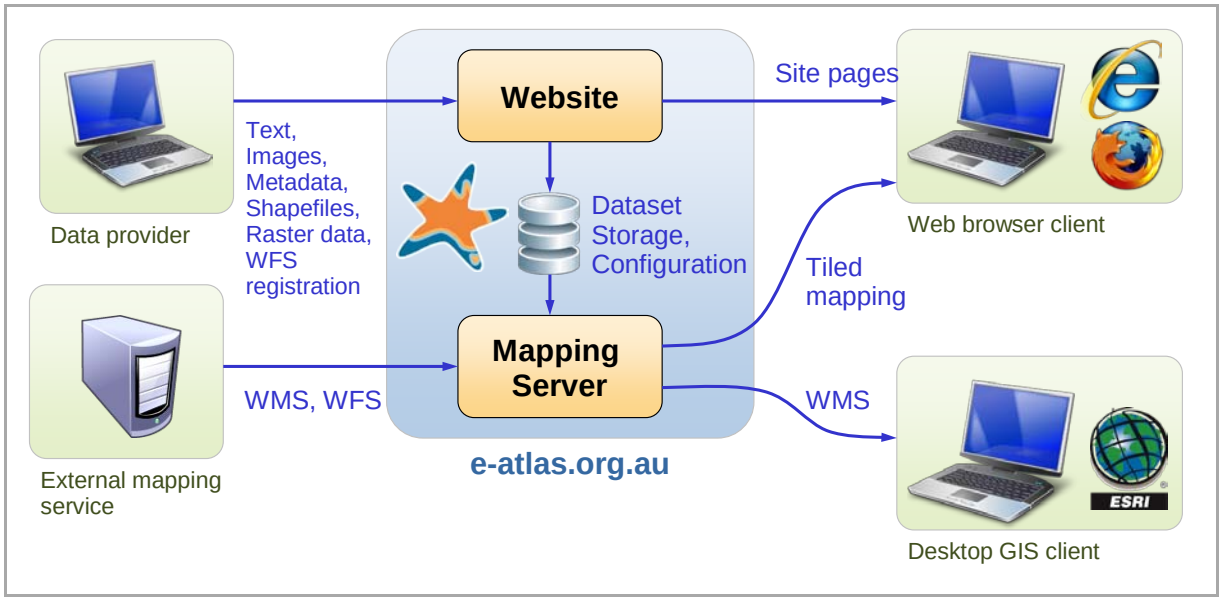


Figure 1: Schematic representation of the architecture of the e-Atlas.

The e-Atlas is based entirely on an open source philosophy and uses a moderated wiki style approach in order to grow through contributions from a wide range of users. The e-Atlas will develop the tools to enable data owners to upload and contribute their contents. The cost savings due to this open source wiki philosophy will be enormous (probably >$200 per uploaded text page, with potentially hundreds of pages being contributed each year). So far,

the system has been populated by the e-Atlas team with the first example pages of content being written and illustrated. Some of the most important data sets have been compiled, and converted into gridded data through statistical tools for mapping and graphic display. The spatial modelling of twelve key data sets comprising over six hundred variables (map layers) is complete, and numerous additional data sets will be added over the next two months. However, in order to initially increase the e-Atlas contents to a critical mass which starts making it useful for potential user organisations such as GBRMPA, a person in charge of uploading the contents will be required in the early period.

In the coming twelve months, priority will be given to the following five areas of development, with the speed of progress dependent on the availability of resources.

1) Development of the Contents Management System and Website

A functional web site and content management system for demonstration to stakeholders and end-users has been created. The content management system allows users to upload and structure text, data and images, and to browse by topic all articles and datasets in the site. Some of the next developmental steps (however presently only partly funded through Project 1.1.5) would include features such as:

1. Refine the development of a custom module for metadata. This will extend the dataset records to include information on variables, layers and basic styling of uploaded data. The existing system only records information at the dataset level and does not have information required to fully integrate the web site with the mapping system. This module will allow all the information required by the mapping system to be entered directly via the web site. This will allow advanced end users to directly add data to the mapping system with minimal involvement from the e-Atlas team.
2. Extend role based permission control to allow institutional management of sensitive datasets and maps, including:
   a. encrypted login support
   b. permission based data download
   c. permission based dataset visibility
   d. integration with mapping system to add access control to maps.
3. Establish access controls for data and maps: The current site contains a sophisticated workflow system that controls access prior to publication but once published, all content is accessible to everyone. We need to be able to restrict access to some datasets and to raw data for many datasets to specific individuals or institutions. This enhancement will allow control over who has access to data associated with datasets and who can view maps.
4. Add advanced searching and additional site navigation such as: browse by contributor and a Google Earth data index. This will allow content to remain easily accessible as more content is added to the site.
5. Create custom linkages to related web-based products
6. Upgrade the management and handling of images. Handling of images in the existing site is error prone, difficult to manage and is missing key features such as attribution of photos. These limitations are due to the use of off-the-shelf modules that were available at the time of development. The handling of images needs to be upgraded as improved modules become available.
7. Improve the site documentation and help. This will include tutorials on how to contribute content to the site and how to access the content already available on the site.
8. Add community involvement features such as mailing lists, newsletters, and blogs. This will help foster a community around the site and ensure that the site is dynamic, encouraging users to regularly use the site.

9. Expand the browser support based on user demand, possibly including IE6 and mobile devices. This will allow the site to reach a wider audience.
10. Add support for near real time datasets. This will allow the e-Atlas to display continually changing datasets.
11. Add features and improvements based on the review by GBRMPA.
12. Enhance site usability including evolution of the front page. Significant improvements to the site will be made based on user feedback. These will enhance the appeal of the site, encouraging community engagement.
13. Add contributor profiles. This will allow users of the site to assess the expertise of the dataset and article contributors and optionally contact them. This will help users have confidence in the information on the site and give contributors useful feedback which may encourage further contributions.

2) Systems Design and Implementation, and Mapping Tools

The mapping tools have reached some level of sophistication, including side-by-side mapping and panning of data from different organisations, and the caching of images to maximise loading speed. Some of the next developmental steps would include features such as:

1. Improve and maintain the server and other hardware and software components
2. Add access control for map layers based on website login. This will allow access to new layers to be restricted prior to publication e.g. during the review of the dataset. The access control will also allow cross-institutional sharing of non-public datasets.
3. Create web interface for the statistical analysis toolbox to enable users to generate interpolated maps over the GBR from point data.
4. Add interactive data analysis based on predefined regions and user selected regions. This will allow statistics for areas of interest to be generated.
5. Add support for additional data formats including oceanographic data (NetCDF, HDF), point data (CSV) and others based on user demand. This will allow stream lined importing of data from a wider range of data providers.
6. Add support for time/depth varying data. This will allow the e-Atlas to present datasets that show changes in the reef over time and allow handling of near real time datasets, such as daily SST.
7. Add features to allow maps to be easily used in publications e.g. image export. This will allow users to quickly generate maps that can be easily imported into documents for publication.
8. Integrate data feeds (using WFS) from external data providers such as AIMS data centre and GBRMPA when they become available. This will allow data providers to manage their own datasets internally while still linking them into the e-Atlas. This will be particularly important for datasets that change regularly.
9. Improve the scalability and robustness of the system so that it can manage 1000s of layers and allow dynamic addition of layers (without server restarts).
10. Move the map layer metadata into a database driven by the website. This will allow users to directly update more aspects of their datasets without the need for manual work by the e-Atlas team.
11. Upgrade the user interface to allow easier searching and management of many map layers. As the number of layer grows large the method for presenting these layers to the user needs to be improved to ensure that they can easily find and manipulate layers of interest.

12. Setup the Spatial Content Management System (SCMS) as a separate open source project. This will allow the systems that have been developed as part of the e-Atlas to be reused, rebranded and used by anyone for creating sites similar to the e-Atlas. The e-Atlas is based on a foundation of existing open source software, making it available as an open source project will give back to this community. Setting up the SCMS as an open source project will involve:
    a. Community site: mailing list, code repository, documentation site, issue tracking
    b. Refactoring of existing code to separate the content from the SCMS.
13. Improve the data submission process to include documentation, tutorials and a workflow system. This will improve and simplify the process of obtaining data from providers, giving them a clear expectation of formats and capabilities of the system.

3) Statistical tools to model and map spatial and temporal data

The extrapolation of point data to maps requires advanced statistical skills and tools. So far, 99% of the about 600 maps shown in the e-Atlas have been created by G. De'ath, based on spatial analysis tools that were custom developed for the e-Atlas. Tools are now being developed to automate much of the data upload, analyses and modelling, and simultaneously generate layers and legends for the mapping system and KMLs for users. This way, users will be able to generate their own maps from their point data. This will give the e-Atlas the capability to vastly increase its map content through custodian and user input. In 2009/10, the analytical tools will be developed to improve automation and capacities, including features such as:

1. A process will be generated to automate the data-modelling (as far is possible) and to simultaneously generate layers and legends for the mapping system and KMLs for users.
2. Integrate the analytical tools into the Reef Atlas for interactive on-line use. This requires:
    a. smartening the tools to ensure appropriate analyses are used
    b. programming of a user interface.
3. Develop analytical tools to allow users to:
    a. relate quantitative point data to regions (eg fish density to zoning)
    b. analyse and display time series data at multiple sites.
4. Restructure all tools to make them more robust and modular. This is necessary as the number of tools increases.
5. Develop a spatial system of analysis for terrestrial analyses equivalent to the "across-along" co-ordinates of the GBRWHA.
6. Document all modelling and analytical tools.

4) Contents provision, technical Outreach and User Engagement

This component is presently not funded through Project 1.1.5. The long-term success of the e-Atlas will require wide-ranging participation by users from various organisations, terrestrial and marine. In order to secure the support and participation of these organisations and individuals, the e-Atlas will perform two key activities:

a) The e-Atlas tools will ensure that the uploading of text and metadata will be simple and robust, requiring only a basic level of computer literacy. However, a person will be required to write and contribute priority content to the e-Atlas in the early days, such as the 76 data sets identified as essential by the GBRMPA Reference group. These data are owned across a range of organisations, and are in varying state of accessibility, with some being ready and available for use, while others may require some cleaning, customisation, and the completion

of data sharing agreements. Furthermore, that person will be the first point of contact to help users to use the e-Atlas tools, and take on an editorial role for contributed content as soon as GBRMPA, MTSRF science providers, and other users start to contribute their data. A proportion of users will also require help with the spatial and temporal data analyses tools. The e-Atlas would therefore ideally employ a technically and statistically skilled support person responsible for adding content to the e-Atlas (however this position is presently unfunded through Project 1.1.5). The role of this person would be to:

a) Liaise with data custodians to provide training and technical support to complete metadata, upload data, etc.;
b) Opening of channels providing access to and sharing of data and information;
c) Edit, format and 'approve' content contributed by others;
d) Upload data and information into the e-Atlas repository and website; and
e) Provide advice on analysis of data and use of e-Atlas tools.

5) Research to underpin the e-Atlas

This component is presently not funded through Project 1.1.5, as priority is being given to system development and automation. However, the e-Atlas will link to risk research provided by the users. In the longer term, the analysis and interpretation of spatial and temporal data, data integration, models and related research on key topics (risk, resilience and response) will remain a key component and priority activity for the e-Atlas team, and will ramp up again once the main development phase is completed. The e-Atlas will provide an ideal platform for complex integrative modelling, such as linking processes on land with the water quality and ecological condition in the GBR, and the e-Atlas team has the skills to deal with such complex data problems.

Staffing Requirements for the e-Atlas

The e-Atlas will remain a work-intensive project over the next 12 months (Jul 2009 – July 2010). A total of 4 FTE will required to complete the development of all main features by June 2010, and to enable users to effectively contribute and utilise its tools. This will involve:

- 1.0 FTE of a programmer for the web site and contents management system (Point 1 above);
- 1.0 FTE of a systems developer, and programmer for the mapping tools (Point 2 above);
- 0.5 FTE for the development of the statistical and analytical tools (Point 3 above);
- 0.3 FTE for project management, engagement of other organisations. Due to its high profile and complex inter-organisational nature, this project requires a high level of project management and coordination;
- 1.0 FTE of a scientist responsible for content, user support, spatial analysis / GIS, editor of contents contributed by others etc (Point 4a above); and
- Members of a technical advisory panel (Point 4b above).

The Project is linked to many other MTSRF Projects across all Themes. Where applicable, models and outputs produced by these projects will be incorporated into the e-Atlas.

Project Outputs/Outcomes

We will continue to develop the web delivery of maps, statistical tools, metadata system and contents management system based on open source software, and continue to develop and implement additional features requested by the main users. We will conduct a hardware upgrade to a faster map server, and continue to conduct training workshops and seminars to communicate the Atlas features to potential contributors.

By June 2010, the e-e-Atlas will be a robust, functional mapping and contents management system as a repository and portal to data, metadata, maps, web pages and reports. Beyond July 2010, the e-Atlas will enter into a period where ongoing maintenance and software upgrades etc will be required, but the main body of development will be completed.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)	Web delivery: complete the development of a functional content management system as a repository and portal to data, maps, web pages and reports.	June 2010
(b)	Mapping: complete the development of a functional web-based mapping system.	June 2010
(c)	Modelling: Statistical analysis and synthesis of selected GBR data sets, with particular emphasis on risks, and the biological implications of management actions such as water quality improvement or the GBR zoning system.	June 2010

Project 1.1.5 Milestone Payments 2009/10

For 2009/10 outputs only Milestones	Date	Payment due
Signing of contract		$43,000
Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Progress Report 1 submission: • Progress update for objectives (a), (b) and (c) (above) (with appropriate attribution of MTSRF funding) [AIMS]	15 Nov 2009	$50,000
Report 2 submission (with appropriate attribution of MTSRF funding) [AIMS]: • Summary of new contents for the GBR Atlas • Summary of the newly developed tools for mapping and modeling for the GBR Atlas	15 June 2010	$50,000
Total MTSRF Funding		**$143,000**

Project 1.1.5 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$143,000	-	$143,000
MTSRF Visual Documentation*	$2,000	-	$2,000
AIMS	-	$320,237	$320,237
Total	**$145,000**	**$320,237**	**$465,237**

AIMS Project 1.1.5 Budget 2009/10

Item	MTSRF	AIMS In-Kind	Total Cost
Salaries	$118,000	$70,001	$188,001
Operating *	$20,000	$15,000	$35,000
Travel	$5,000	-	$5,000
Vessels	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$235,236	$235,236
Total	**$143,000**	**$320,237**	**$463,237**

* Including contract for Content Management/Programmer

Background Intellectual Property

This project will utilise and refer to a substantial body of background data owned by the Research Provider (AIMS) and other third parties. These background data sets will be characterised as 'Existing Material' for this project because the data sets existed prior to the commencement of this project. Notwithstanding Clause 16 of the contract between the Research Provider and the RRRC, this Existing Material may be cited or incorporated into the project for delivery of the project needs but will not be supplied as stand alone data sets as part of the project. Ownership of the Existing Material will vest within the Research Provider. For the purpose of clarity, the parties agree that the Research Provider will contribute findings, reports and other outputs based on the Existing Material but nothing in this agreement requires the Research Provider to contribute and distribute the original data. It is not possible to identify all of the Existing Materials that may be included in this project during its year lifespan. The Research Provider retains ownership of the all data sets referenced in project reports submitted to the RRRC including, but not limited to, data sets derived from surveys and long-term monitoring data of hard and soft corals, algae, fish, crown-of-thorns starfish, coral calcification, water quality and sea surface temperature.

PROGRAM 2
STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE WET TROPICS RAINFORESTS

Program Leader and Host Organisation

Dr James Butler, Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Program 2 Budget Summary

	Cash	In-kind	Total
MTSRF	$350,000	-	$350,000
Other	-	$479,918	$479,918
Total	**$350,000**	**$479,918**	**$829,918**

Program 2 will continue to report on the condition and trend of key environmental assets, including ecosystem processes and biodiversity, in the Wet Tropics rainforests and catchments. This Program will collate and evaluate current knowledge on biodiversity and other environmental assets delivered by ecosystem processes. To provide further data, targeted gap filling will now take precedence and the baseline developed for comprehensive condition monitoring and reporting of the North Queensland rainforest environmental assets will be used to focus on a report card for the biodiversity asset.

The Program will continue to build on the existing metadata banks developed under the Rainforest CRC, with an increased focus on the lowland rainforest areas that are experiencing increased threatening processes. The Program is linked to projects within Theme 2 (Program 5ii: *Climate Change – Rainforests and Catchments*), Theme 4 (Program 9: *Sustainable Use, Planning and Management of Tropical Rainforest Landscapes*). The Program will continue to develop rainforest monitoring methods and implement the refined monitoring protocol on existing and newly focused monitoring sites. Tools for measuring, monitoring and reporting have been developed and identify priorities for management action. The mining of existing data sets and the focused monitoring program will produce a flow of complex ecosystem information. Thus, the Program will collaborate with the relevant managing agencies and user groups to provide information that will contribute to Integrated Reporting for the Wet Tropics World Heritage Area and North Queensland's coastal catchments by assimilating data from multiple sources with an emphasis on quantitative indicators of condition and trend and performance assessment of systems against thresholds of critical concern. This approach will be developed in collaboration with Program 10, and the results will be used to assist management agencies in *State of the Environment* reporting, including international obligations for World Heritage Periodic reporting.

Despite a number of attempts to do so, there has never been an integrated monitoring program across the Wet Tropics World Heritage Area that satisfies the reporting requirements of the Wet Tropics Management Authority and the Department of the Environment, Water, Heritage and the Arts; nor has one been available for the coastal catchments outside the World Heritage Area. In part, this is because it has always been seen as too costly, which in turn has been partly because no one has been able to pin down a set of indicators that are both affordable and sufficiently robust for reporting.

Projects

1.2.1a Identification Skills Workshops – Australian tropical rainforest plants.....$50,000

1.2.1b Biodiversity monitoring for climate change.....$65,000

1.2.1c Status and trends of biodiversity and ecosystem services – *State of the Environment* reporting and gap filling.....$200,000

1.2.1d Insect Diversity $35,000

PROGRAM 2: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE WET TROPICS RAINFORESTS

Project 1.2.1a: Continuation: Identification Skills Workshops – Australian Tropical Rain Forest Plants (Status and trends of biodiversity and ecosystem services)

Project Leader and Host Organisation

Professor Darren Crayn, Australian Tropical Herbarium

Project Team 2009/10

Title	Organisation	Role	FTE
Prof Darren Crayn	ATH	development and delivery of workshops	0.05
Mr Stuart Worboys	ATH	development and delivery of workshops	0.50
Mr Frank Zich	ATH, CSIRO PI	development and delivery of workshops	0.20
Ms Andrea Lim	ATH	Administrative/Technical Support	0.05
Ms Ellen Weber	WTMA	development and delivery of workshops	0.10
Dr Steve Goosem	WTMA	development of workshop materials	0.05
Dr Judy West	CSIRO PI	development of workshops	0.05
A/Prof Betsy Jackes	JCU	development and delivery of workshops	0.10
Knowledge Broker (TBA)	TRIN, MTSRF	Knowledge broker	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Andrew Maclean, Steve Goosem, Ellen Weber
Community	Plant enthusiasts, bushwalkers, Indigenous communities
Regional Councils	Environmental and NRM officers at Cairns, Townsville, Cassowary Coast, Cook Hinchinbrook, Yarrabah and Wujal, Shire Councils
Conservation Volunteers Australia	Amanda McCall
Society for Growing Australian Plants	Mary Gandini
Other NGOs	Revegatation groups (BRICMA, TREAT, Treeforce, C4, Kuranda Conservation)
Tertiary Students	Andrew Krockenberger (Dept. Head, School of Marine and Tropical Biology, JCU)
Government	Biosecurity QLD, DERM, QPWW rangers, Land managers; AQIS - Barbara Waterhouse;
Tour guides	TBA
Environmental consultants	TBA

Project Duration

Start Date: 1 July 2009 End Date: 30 June 2010

Project Description / Task Objectives

The objectives of this project are to:

1. Use interactive plant identification keys to provide practical hands-on training for informed members of the wet tropics community (e.g. land mangers, students, NGO groups) to learn and develop skills in plant identification techniques;
2. Provide accredited training plant ID for TAFE and university students and land managers;
3. Generate community interest and awareness and appreciation of the diverse and unique local and regional flora;
4. Provide a forum for the community to engage with the local research community, university and herbarium; and
5. Provide a forum for the community to provide feedback on the newly launched rainforest plant identification key.

The team will develop workbook materials and conduct a series of plant identification workshops for a range of end users in a various locations in the wet tropics region. The workshops will be developed for various skill levels.

The identification workshops will be based on the **Interactive Key to Australian Rain Forest Plants** including the recent work funded under MTSRF Project 1.2.1a (forbs), and the orchid and fern modules. The workshops will be delivered by experienced botanists and it is anticipated that they will initially be run in Cairns, Atherton, Cooktown, Townsville, and other locations depending on demand.

The workshops will include testing and seeking user feedback on the new interactive key modules developed under MTSRF Project 1.2.1a once beta versions are developed.

It is anticipated that workshops will be accredited as approved training courses through JCU (School of Marine and Tropical Biology) and the Cairns TAFE. It is expected that up to five free one-day accredited workshops will run throughout the region for beginners and one four-day intensive workshop will be run for tertiary participants to gain formal accreditation.

The project will have significant linkages with other MTSRF Rainforest and Catchments project, examples of which are provided in Table 1.

Table 1: Summary of key linkages between MTSRF Project 1.2.1a Continuation and other MTSRF Rainforests and Catchments projects.

MTSRF Project	Linkage
1.4.3: Threatened Species and Communities	Improved plant identification skills will contribute to better management of threatened species and communities
2.5ii.3: Understanding climate change threat to ecosystems and ecological processes	Awareness of climate change impacts on distribution of plant biodiversity within and outside WHA
2.6.2: Identification and impact of invasive pests in the Wet Tropics Rainforest	Understanding of identification, distribution and ecology of invasive species with particular reference to weeds in region
4.9.1: Indigenous Landscapes of the Wet Tropics	Improved plant identification skills of Indigenous participants will assist in assessing indicators of biodiversity and ecosystem health and help to link traditional and scientific knowledge systems
4.9.3: Impacts of urbanisation on North Queensland environments: management and remediation	Detecting impacts of fragmentation on plant biodiversity and ecosystem services and implementing solutions requires accurate plant identification.
4.9.4: Integrating ecology, economics and people in forest and landscapes	Sustainable use of forests and landscapes requires accurate plant identification.
4.9.5: Restoring tropical forest landscapes	Restoration ecology is critically dependent on accurate plant identification.
4.9.6: Strategic Natural Resource Management and land use planning	Awareness and expertise on local pressures and state of biodiversity and ecosystem services

Project / Task Methodology

This project will proceed as a cooperative partnership between the Australian Tropical Herbarium (ATH), Wet Tropics Management Authority (WTMA), and CSIRO Plant Industry (CPI). The project team will develop manuals and run a series of complementary 1-2 day workshops on the identification of native and naturalised northeast Queensland plants with particular emphasis on the wet tropics flora.

Workshop materials will be developed in a module format, to enable each module to 'stand alone' or be combined with others on an as-needed basis, for example:

a) Introduction to identifying plants;
b) Australian tropical rain forest plants;
c) Orchids of the Wet Tropics;
d) Ferns of the Wet Tropics; and
e) Weeds of the Wet Tropics

The focus of the workshops will be on the development of general and specific plant identification skills, and include a significant component of hands-on use of computer-based interactive keys for Australian tropical rain forest plants.

James Cook University, through the School of Marine and Tropical Biology, has expressed keen interest in recognising the workshops toward tertiary courses.

Project Outputs/Outcomes

During the period of this contract the following outcomes related to the Rainforest Plant Key are expected. These include outcomes scheduled from Project 1.2.1a as well as this current proposal for Project 1.2.1a Continuation:

1. RFK conversion to LUCID
2. RFK Forb (Herb) module completed
3. Plant Identification modules developed
4. Plant identification workshops conducted

Project 1.2.1a Continuation Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)	Develop and finalise course module materials	November 2009
(b)	Beta version of RFK in Lucid	end 2009
(c)	Obtain course accreditation	January 2010
(d)	Conduct 5x 1-day workshops, ca. up to 20 participants at each : Cairns, Atherton, Cooktown, Townsville Others as required eg. Ingham, Darwin	June 2010

Project 1.2.1a Continuation Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**ATH**
Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Sign contract	Jul 2009	$30,000
Progress Report 1: Summary of any communication activities undertaken to date, including minutes of meetings/workshops [ATH]	15 Feb 2010	$15,000
Progress Report 2: Report on completion of plant identification workshops with appropriate attribution of MTSRF Funding [ATH]	15 June 2010	$5,000
Total MTSRF Funding		**$50,000**

Project 1.2.1a Continuation Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$50,000	-	$50,000
CSIRO ATH	-	$16,044	$16,044
WTMA	-	$15,500	$15,500
CSIRO Plant Industry	-	$61,050	$61,050
Total	**$50,000**	**$92,594**	**$142,594**

JCU Australian Tropical Herbarium 1.2.1a Continuation Budget 2009/10

Item	MTSRF	ATH – In Kind	Total Cost
Salaries	$36,600	$9,715	$44,315
Operating	$1,300	$1,900	$3,200
Travel	$3,500	$2,000	$5,500
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	$8,600	$2,429	$11,079
Total	**$50,000**	**$16,044**	**$66,044**

WTMA 1.2.1a Continuation Budget 2009/10

Item	MTSRF	WTMA – In Kind	Total Cost
Salaries	-	$11,000	$11,000
Operating	-	-	-
Travel	-	$2,000	$2,000
Communication / Extension	--	$2,500	$2,500
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**$15,500**	**$15,500**

CSIRO PI 1.2.1a Continuation Budget 2009/10

Item	MTSRF	CSIRO – In Kind	Total Cost
Salaries	-	$28,342	$28,342
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$32,708	$32,708
Total		**$61,050**	**$61,050**

PROGRAM 2: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE WET TROPICS RAINFORESTS

Project 1.2.1b: Biodiversity monitoring for climate change

Project Leader and Host Organisation

Assoc. Prof. Stephen Williams
Centre for Tropical Biodiversity and Climate Change, James Cook University

Project Team commitments 2009/10

Title	Organisation	Role	FTE
Steve Williams	JCU	Biodiversity specialist	0.15
Jeremy VanDerWal	JCU	Spatial ecologist	0.10
Collin Storlie	JCU	Research Assistant	1.0
Rohan Wilson	JCU/ANU	PhD student	1.0

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Steve Goosem, Ellen Weber
Terrain NRM Ltd	Kath Shurcliff, Rowena Grace, Deb Harrison
EPA	Paul Williams
Alliance for Sustainable Tourism	John Courtenay

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

To provide the knowledge and methods needed for accurate and up-to-date state of the region reporting on the key biodiversity and ecosystem services assets of North Queensland, to support future iteration of NRM planning and the management of the Wet Tropics WHA, through:

(a) A synthesis of current knowledge and identification of gaps for key biological and environmental assets;
(b) Filling knowledge gaps in conjunction with field surveys being carried out in Project 1.4.3 (*Threatened species and communities*), Project 2.6.2 (*Identification and impact of invasive pests in the Wet Tropics Rainforest*) and completion of the *Interactive Key to Australian Rain Forest Plants*;
(c) Design and test a monitoring program to track status and trends of key environmental assets and ecosystem services.

Project / Task Methodology

This project will proceed as a co-research partnership between CSIRO, JCU, MTSRF, WTMA and Terrain NRM Ltd. It is not possible to separate science and end users roles clearly because knowledge, management, monitoring and reporting are all joint responsibilities. The methods are introduced below, under two headings, knowledge synthesis and gap filling, and the design of a monitoring program. In fact, the monitoring program will depend critically on the data base available from synthesising knowledge and filling any gaps, and the monitoring program will in turn provide data back to the data base to improve knowledge in an iterative way. The project will provide a synthesis of current knowledge and databases on key biological and environmental assets in the Wet Tropics World Heritage Area, and design and trial of a potentially suitable and cost-effective monitoring program to track the status and trends of key indicators of ecological health and ecosystem services. The project is linking with nine other relevant MTSRF projects in the Rainforest and Catchments theme (Table 1), and monitoring and evaluation projects in other MTSRF themes, with particular reference to the Torres Strait (Project 1.3.5) and Great Barrier Reef (Project 1.1.2). In addition, parallel projects not funded by MTSRF will continue to feed into the social and community-based facets of the project, including projects investigating Indigenous knowledge and approaches to monitoring biodiversity and human well-being (Table 2).

Objective (a) and (b): Knowledge synthesis and gap filling

The Wet Tropics NRM region, which includes North Queensland's eastern coastal catchments and much of the Wet Tropics World Heritage Area (WHA), supports a range of complex and diverse ecosystems and a large number of rare, endemic or iconic species. These natural assets provide a broad range of ecosystem services to the local community and society at large. Whilst years of research at various scales, geographical extents and taxonomic levels have been carried out within the region, there is no central repository for this information, and there has been no coordinated attempt to establish a baseline dataset. Biological data from existing CSIRO plant and animal collections have been compiled and managed in a data base, but there are gaps in the coverage of the region and of the biota. Socio-economic data have also been compiled and are managed in a similar way, but again, there are gaps in coverage. Establishment of a suitable baseline provides the foundation for comprehensive condition monitoring, allows the range of existing work to be assessed and promotes integration or linkages between projects, and will highlight areas where gaps in existing data coverage remain.

To provide further data, targeted gap-filling will continue to enable a good quality baseline to be completed which will provide a foundation for monitoring. This will continue to focus on coastal lowland communities on putative upland refugial areas that are remote from the main road network and have been chronically under-surveyed, and on the distribution of non-scheduled weeds, for which there is no legislative requirement for monitoring. Targeted gap filling in conjunction with Project 1.4.3 commenced early in Year 1 of this project. There will be regular scrutiny of the gap-analysis models as gaps are filled to ensure priority areas are being targeted. Reporting of baseline data to support the design and monitoring phase of the project will occur as significant gaps are filled. Data generated will also feed into Projects 2.6.2 and 4.9.6.

WTMA and Terrain NRM Ltd will continue to work with the research team to develop GIS layers of key environmental assets utilising both species data sets and environmental and socio-economic data sets.

Objective (c): Design and implementation of a monitoring program

Year 4 of this project builds upon the work conducted in Years 1-3 in terms of objective (c). This has achieved the following:

1. An agreed conceptual framework identifying natural assets, ecosystem services and key ecological functions and processes supplying these services, based on expert workshops held in June-August 2007;
2. Potential indicators of the condition of ecological functions, and pressures/threats to these functions;
3. Prioritisation of headline indicators based on network analysis;
4. Exploration of options for synthesising and presenting headline indicators and ecosystem services; and
5. Collation of data sets relevant to headline indicator development.

The project will now focus on delivering a trial 'report card' for the Biodiversity asset, based on the framework and indicators developed in Years 1-3. This will combine the requirements of WTMA for reporting WHA condition and pressures, and Terrain NRM's review of the Wet Tropics Natural Resource Management Plan, including Resource Condition Targets and Management Action Targets. This will form the blueprint for reporting of the other regional assets, Climate, Water/Wetlands and Soil/Landscape in Year 4. In Year 4 the work programme will achieve the following:

1. An agreed baseline for monitoring;
2. Collation of data sets from WTMA, Terrain NRM and other sources to populate agreed indicators;
3. Trends in condition and pressures against agreed targets and thresholds of concern; and
4. Delivery of a reporting shell appropriate to the scale of issues under consideration.

The work program will also explore the feasibility of spatially evaluating and mapping the ecosystem service of carbon sequestration in the Wet Tropics, to support Terrain NRM's Degrees Celsius Joint Venture on voluntary carbon markets.

In addition, the monitoring program will include links between local communities and biodiversity health. For Indigenous communities this will be achieved through continued links with cultural mapping undertaken by Project 4.9.1 (Indigenous Landscapes of the Wet Tropics). A CSIRO-funded post-doctoral fellow, Dr Leanne Cullen, will provide an in-kind contribution (0.25 EFT) to develop indicators for Indigenous and non-Indigenous communities linked to biodiversity health and condition. These sociological aspects of Status and Trends will deliver to Terrain's requirement to assess and monitor their 'People and Country' asset, and WTMA's requirement to ensure the Wet Tropic World Heritage Area's relevance to the local community. Links with Project 4.9.7 (Measuring social resilience in relation to water quality) will also continue to be developed.

Project Activities (indicative for out years only)

Objective	Targeted Activity	Completion Date
(a)	Meta-database created and established with recommendations for future management	Jun 2010
(b)	Existing data sets for natural assets identified, and knowledge gaps identified. Assessment of the usefulness and limitations of existing available data sets and coverage, and what can be used in the interim, medium or long- term. Recommendations developed for future research requirements to fill key knowledge gaps.	Jun 2010
(c)	Prototype report card for Biodiversity asset, including trends and thresholds of concern and incorporating JCU altitudinal biodiversity surveys and CSIRO lowland communities surveys.	Jun 2009

Project 1.2.1b Milestones 2009/10

For 2009/10 outputs only **Milestones [agency responsible for report delivery identified in brackets]**	**Date**	**JCU**
Signing of contract		$30,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Progress Report 1: • Summarise progress on the collection of weather station data • Summarise progress on fauna monitoring • Describe extension to coverage of formal sampling of rainforest birds - north to Cape York Peninsula (far North Queensland) and south to Eungella (mid-east Queensland).	3 Dec 2009	$20,000
Progress Report 2: • Summarise three years of daily weather data from 25 rainforest weather stations deployed and maintained under the project (2006-2009). • Provide weather station temperature and humidity data to Michael Hutchinson (Centre for Resource and Environmental Studies at the Australian National University). Additional data will fill gaps in the regional weather station network and contribute to the generation of improved regional climate layers via future reruns of ANUCLIM. • Provision of regional coverages of microclimate to eAtlas (a feedback from Obj. d MTSRF Project 2 5ii 4) • Final report on fauna monitoring and how vertebrate and invertebrate data has been utilised in MTSRF and other related projects • Summarise extent of baseline data set accumulated for rainforest fauna and identify key areas (taxonomic groups, locations of intensively sampled sites) where data set will be most amenable to the detection of change in the status of species in the future. • Comment on future extensions for research completed under MTSRF Project 1.2.1B. • Attribution of MTSRF funding in all products.	1 Jun 2010	$14,125
Total MTSRF Funding*		**$64,125**

Project 1.2.1b Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$64,125	-	$64,125
MTSRF Visual Documentation*	$875	-	$875
JCU	-	$78,985	$78,985
WTMA	-	$20,000	$20,000
Total	**$65,000**	**$98,985**	**$163,985**

* A total of $875 is held by the RRRC for Visual Documentation of this project (see Theme 5).

James Cook University Project 1.2.1b Budget 2009/10

Item	MTSRF Funds	In-kind	Total Cost
Salaries	$60,500	$8,985	$67,485
Operating	$1,500	-	$1,500
Travel	$2,125	-	$4,125
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$70,000	$70,000
Total	**$64,125**	**$78,985**	**$141,110**

Communication Products / Events 2009-2010

The following products and events have been agreed with the Reef and Rainforest Research Centre and are to be reported against milestones above.

Objective	Proposed communication product / event	Date
All	End user briefing sessions.	On request for specific policy needs
All	Provision of content for website updates and project visual documentation.	Ongoing
All	Provision of content for Fact Sheets, depending on MTSRF Communication Strategy and enduser requirements.	Several throughout Program in consultation with end users
	Enduser collaboration in research project.	Throughout project

Table 1: Summary of existing and proposed linkages between MTSRF Project 1.2.1 and other MTSRF Rainforests and Catchments projects.

MTSRF Project	Linkage
1.4.3: Threatened Species and Communities	Geospatially referenced data from field surveys provided to compliment gap filling efforts on areas outside WHA
2.5ii.3: Understanding climate change threat to ecosystems and ecological processes	Data and expertise on climate change impacts in biodiversity within and outside WHA
2.6.2: Identification and impact of invasive pests in the Wet Tropics Rainforest	Data on distribution and ecology of invasive species with particular reference to fish and weeds
4.9.1: Indigenous Landscapes of the Wet Tropics	Collaboration on identification of Indigenous indicators of biodiversity and ecosystem health
4.9.3: Impacts of urbanisation on North Queensland environments: management and remediation	Data and expertise on impacts of roads, traffic and fragmentation on biodiversity and ecosystem services
4.9.4: Integrating ecology, economics and people in forest and landscapes	Data and expertise on biodiversity values of timber plantations outside WHA
4.9.5: Restoring tropical forest landscapes	Data and expertise on biodiversity values of forest restoration projects outside WHA
4.9.6: Strategic Natural Resource Management and land use planning	Data and expertise on local pressures and state of biodiversity and ecosystem services (e.g. Mission Beach)
4.9.7 Measuring social resilience in relation to water quality	Integration of social resilience data with biophysical monitoring data

PROGRAM 2: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE WET TROPICS RAINFORESTS

Project 1.2.1c: Status and trends of biodiversity and ecosystem services: State of the Environment reporting and gap filling

Project Leaders and Host Organisation

Dr James Butler and Dr Petina Pert, CSIRO and Australian Tropical Forest Institute

Project Team commitments 2009/10

Title	Organisation	Role	FTE
James Butler	CSIRO	Human ecologist, Project 1.2.1(a-d) Leader	0.06
Petina Pert	CSIRO	Project 1.2.1c Leader and GIS data analysis	0.40
Dan Metcalfe	CSIRO	Tropical plant ecologist	0.10
Tony Webster	CSIRO	Agricultural systems	0.15
Leanne Cullen	CSIRO	Human ecologist (CSIRO postdoc, in-kind)	0.25
Andrew Ford	CSIRO	Botanist and taxonomic support	0.23
Matt Bradford	CSIRO	Plant ecology research support	0.10
Caroline Bruce	CSIRO	GIS and data management	0.30
Tina Lawson	CSIRO	GIS and data Management	0.32

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Steve Goosem, Ellen Weber
Terrain NRM Ltd	John Reghenzani, Rowena Grace, Deb Harrison, Sharlene Blakeney
EPA	TBA
Alliance for Sustainable Tourism	TBA

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

To provide the knowledge, methods and results of accurate and up-to-date state of the environment reporting on the key biodiversity and ecosystem services assets of North Queensland, to support future iteration of NRM planning and the management of the Wet Tropics World Heritage Area (WHA), through the:

(a) Design, testing and delivery of user-friendly monitoring and reporting tools to track status and trends of key environmental assets and ecosystem services;
(b) Collation of relevant data sources in a format suitable for access by all project partners for state of the environment reporting;
(c) Filling of knowledge gaps in conjunction with field surveys being carried out in Project 1.4.3 (*Threatened species and communities*), Project 2.6.2 (*Identification and impact of invasive pests in the Wet Tropics Rainforest*), and identification of other gaps requiring future research investment.

Project / Task Methodology

The Wet Tropics NRM region, which includes North Queensland's eastern coastal catchments and much of the Wet Tropics WHA, supports a range of complex and diverse ecosystems and a large number of rare, endemic or iconic species. These natural assets provide a broad range of ecosystem services to the local community and society at large.

This project will identify key ecosystem services provided by these assets, develop indicators for tracking their status and trends, present results and trial a reporting framework suitable for all partners. It will also create a synthesis of current knowledge and databases on key biological and environmental assets in the Wet Tropics, including the WHA and the Terrain NRM region. The project draws on information gathered by nine other relevant MTSRF projects in the Rainforest and Catchments theme (Table 1), and monitoring and evaluation projects in other MTSRF themes, with particular reference to the Torres Strait (Project 1.3.5) and Great Barrier Reef (Project 1.1.2). In addition, parallel projects not funded by MTSRF will continue to feed into the social and community-based facets of the project, including a CSIRO-funded post-doctoral project on the development of linked cultural and ecological indicators of ecosystem health. The project is being undertaken as a co-research partnership between CSIRO, JCU, MTSRF, WTMA and Terrain NRM Ltd.

Objective (a): Design and testing of a monitoring and reporting program

Year 4 of this project delivers on the work conducted in Years 1-3 in terms of objective (a). This has achieved the following:

1. An agreed conceptual framework identifying natural assets, ecosystem services and key ecological functions and processes supplying these services, based on expert workshops held in June-August 2007;
2. Potential indicators of the condition of ecological functions, and pressures/threats to these functions;
3. Prioritisation of headline indicators based on network analysis;
4. Exploration of options for synthesising and presenting headline indicators and ecosystem services;
5. Collation of data sets relevant to headline indicator development;
6. Application of these to a 'report card' for the Biodiversity asset.

In Year 4 the work programme will achieve the following:

1. Completion of the Biodiversity asset report card;
2. Completion of the Soils and Landscapes report card.
3. Delivery of technical reports and scientific papers in collaboration with Terrain NRM and WTMA.

In addition, the monitoring program will include links between local communities and biodiversity health. For Indigenous communities this will be achieved through continued links with cultural mapping undertaken by Project 4.9.1 (*Indigenous Landscapes of the Wet Tropics*). A CSIRO-funded post-doctoral fellow, Dr. Leanne Cullen, will provide an in-kind contribution (0.25 EFT) to develop cultural indicators for Indigenous and non-Indigenous communities linked to ecosystem health. These sociological aspects will deliver to Terrain's requirement to assess and monitor their 'People and Country' asset, and WTMA's requirement to ensure the Wet Tropic World Heritage Area's relevance to the local community. Links with Project 4.9.7 (*Measuring social resilience in relation to water quality*) will also continue to be developed.

Objective (b): Collation of relevant data sources

The collation of relevant data sources will continue in Year 4. Data sharing agreements with relevant partners will continue to be established to allow the accessible organisation of information. A central data hub is being established on the CSIRO server in the Australian Tropical Forest Institute, James Cook University, Cairns, with access arrangements for all partners.

Data produced by a Project 1.2.1 sub-project involving the collection of biodiversity data from altitudinal transects in the WHA by James Cook University (also linked to 2.5ii.3 *Understanding climate change threat to ecosystems and ecological processes*) will also be collated for use in the Biodiversity and other report cards.

Objective (c): Filling of knowledge gaps

Whilst years of research at various scales, geographical extents and taxonomic levels have been carried out within the region, there is no central repository for this information, and there has been no coordinated attempt to establish a baseline dataset. Biological data from existing CSIRO, Environment Protection Agency and QPIF plant and animal databases are being compiled and managed through Objective (b) of this project, but there remain gaps in the coverage of the region and of the biota.

To provide further data, targeted gap-filling field surveys will continue. This will focus on coastal lowland communities on putative upland refugial areas that are remote from the main road network and have been chronically under-surveyed, and will include the distribution of feral and weed species throughout the region. Targeted gap filling in conjunction with Project 1.4.3 commenced early in Year 1 of this project. There will be regular scrutiny of the gap-analysis models as gaps are filled to ensure priority areas are being targeted. Reporting of baseline data to support the design and monitoring phase of the project will occur as significant gaps are filled. Data generated will also feed into Projects 2.6.2 and 4.9.6.

In the development of indicators and relevant data sets in Objective (a), research priorities will also be identified to fill broader gaps in knowledge.

Project 1.2.1c Milestones 2009/10

For 2009/10 outputs only **Milestones [agency responsible for report delivery identified in brackets]**	Date	CSIRO CSE
Signing of contract		$58,005
Project Leader to attend Operations Committee Meetings (three to four meetings per year).	09/10	-
Progress Report 1: • Progress report on report card and available data collation for Biodiversity asset, and the undertaking of practical trials in collaboration with WTMA and Terrain • Interim report on the reporting of the Soils and Landscapes asset, and the undertaking of practical trials in collaboration with WTMA and Terrain • Update on gap analysis and gap filling of poorly-documented species and communities, and contributions to Biodiversity asset report card. • Summary of any communication activities undertaken to date, including minutes of meetings/workshops.	3 Dec 2009	$70,000
Final Reports: • Final report on the status and trends of environmental assets in the Wet Tropics resulting from practical trials in collaboration with WTMA and Terrain (with attribution of MTSRF funding). • Final report on gap analysis and gap filling of poorly-documented threatened species and communities • Final report on key recommendations and findings for future state of the environment reporting (with attribution of MTSRF funding). • Summary of any communication activities (including scientific papers) undertaken to date, including minutes of meetings/workshops.	1 Jun 2010	$70,000
Total MTSRF Funding		**$198,005**

Project 1.2.1c Budget

Year 4 – 2009/10 Project Funding and Partnership

Contributing Organisation	Cash	In-kind	Total
MTSRF*	$198,005	-	$198,005
MTSRF visual documentation	$1,995	-	$1,995
CSIRO Sustainable Ecosystems	-	$176,339	$176,339
Terrain NRM Ltd	-	$36,000	$36,000
WTMA	-	$20,000	$20,000
Total	**$200,000**	**$232,339**	**$432,339**

CSIRO Sustainable Ecosystems Project 1.2.1c Budget 2009/10

Item	MTSRF Funds	In-kind	Total Cost
Salaries	$165,497	$22,000*	$187,497
Operating	$26,451	-	$26,451
Travel	$6,057	-	$6,057
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$155,371	$155,371
Total	**$198,005**	**$177,371**	**$375,376**

* Leanne Cullen (CSIRO Postdoc) salary in-kind

Wet Tropics Management Authority Project 1.2.1c Budget 2009/10

Item	MTSRF Funds	In-kind	Total Cost
Salaries	-	$20,000	$20,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**$20,000**	**$20,000**

Terrain NRM Ltd Project 1.2.1c Budget 2009/10

Item	MTSRF Funds	In-kind	Total Cost
Salaries	-	$36,000	$36,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**$36,000**	**$36,000**

Communication Products / Events 2009-2010

The following products and events have been agreed with the Reef and Rainforest Research Centre and are to be reported against milestones above.

Objective	Proposed communication product / event	Date
All	End user briefing sessions.	On request for specific policy needs
All	Provision of content for website updates and project visual documentation.	Ongoing
All	Provision of content for Fact Sheets, depending on MTSRF Communication Strategy and enduser requirements.	Several throughout Program in consultation with end users
All	Enduser/science workshops to develop Biodiversity and Soils and Landscapes asset report card shells.	July 2009 - June 2010
All	Enduser collaboration in research project.	Throughout project

Table 1: Summary of existing and proposed linkages between MTSRF Project 1.2.1c and other MTSRF Rainforests and Catchments projects.

MTSRF Project	Linkage
1.4.3: Threatened Species and Communities	Geospatially referenced data from field surveys provided to compliment gap filling efforts on areas outside WHA
2.5ii.3: Understanding climate change threat to ecosystems and ecological processes	Data and expertise on climate change impacts in biodiversity within and outside WHA
2.6.2: Identification and impact of invasive pests in the Wet Tropics Rainforest	Data on distribution and ecology of invasive species with particular reference to fish and weeds
4.9.1: Indigenous Landscapes of the Wet Tropics	Collaboration on identification of Indigenous indicators of biodiversity and ecosystem health
4.9.3: Impacts of urbanisation on North Queensland environments: management and remediation	Data and expertise on impacts of roads, traffic and fragmentation on biodiversity and ecosystem services
4.9.4: Integrating ecology, economics and people in forest and landscapes	Data and expertise on biodiversity values of timber plantations outside WHA
4.9.5: Restoring tropical forest landscapes	Data and expertise on biodiversity values of forest restoration projects outside WHA
4.9.6: Strategic Natural Resource Management and land use planning	Data and expertise on local pressures and state of biodiversity and ecosystem services (e.g. Mission Beach)
4.9.7 Measuring social resilience in relation to water quality	Integration of social resilience data with biophysical monitoring data

PROGRAM 2: STATUS AND TRENDS OF SPECIES AND ECOSYSTEMS IN THE WET TROPICS RAINFORESTS

Project 1.2.1d: Insect Diversity

Project Leader and Host Organisation

Professor Nigel Stork, The University of Melbourne

Project Team 2009/10

Title	Organisation	Role	FTE
Professor Nigel Stork	The University of Melbourne	Project Leader	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Dr Steve Goosem

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This project is providing information on the variation in insect abundance and diversity at different, altitudes, locations and seasons throughout the central Wet Tropics from Paluma to the Windsor Uplands. Insects are arguably the most speciose animal group on the planet and play important roles in terrestrial ecosystems. Understanding how they vary in abundance and diversity across the Wet Tropics landscape is vitally important to providing some measures of how susceptible these ecosystem processes are to environmental change, particularly climate change.

Tasks:

1. Report on first model of insect abundance across the Wet Tropics landscape including seasonal change
2. Report on first model of insect diversity (species richness) across the Wet Tropics landscape using selected taxa
3. Report describing first assessment of extinction proneness of insects in the Wet tropics using beetles as an indicator group.

Project / Task Methodology

Insects have been sampled using Flight Intercept Traps for more than one year on a range of sites at different altitudes and transects managed by Prof Steve Williams and his group. Beetles have been removed from these samples and counts made. Given the enormous number of individuals in the samples, five beetle families are now the focus for the next stage of specimen preparation and species sorting. These families are selected on the basis of previous non-MTSRF research on the Atherton Tablelands and Rainforest CRC funded studies at the canopy crane.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
1	Report on first model of insect abundance across the Wet Tropics landscape including seasonal change.	June 2009
2	Report on first model of insect diversity (species richness) across the Wet Tropics landscape using selected taxa.	Dec 2009
3	Report describing first assessment of extinction proneness of insects in the Wet tropics using beetles as an indicator group.	June 2010

Project 1.2.1d Milestone Payments 2009/10

For 2009/10 outputs only Milestones	Date	Uni Melb
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
• Progress report on first model of insect abundance across the Wet Tropics landscape including seasonal change	15 July 2009	$10,000
• Progress report on first model of insect diversity (species richness) across the Wet Tropics landscape using selected taxa	15 Dec 2009	$10,000
• Final publishable report (with attribution to MTSRF) describing first assessment of extinction proneness of insects in the Wet tropics using beetles as an indicator group.	1 June 2010	$15,000
Total MTSRF Funding		**$35,000**

Project Funding and Partnerships 2009/10

Project 1.2.1d Budget 2009/10

Contributing Organisation	Cash	In-kind	Total
MTSRF	$35,000	-	$35,000
MTSRF Visual Documentation*	-	-	-
University of Melbourne	-	$20,000	$20,000
Total	**$35,000**	**$20,000**	**$55,000**

University of Melbourne Project 1.2.1d Budget 2009/10

Item	MTSRF	MelbUni – In Kind	Total Cost
Salaries	$35,000	$20,000	$55,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$35,000**	**$20,000**	**$55,000**

PROGRAM 3
TORRES STRAIT – STATUS, USE AND TRENDS

Program Leader and Host Organisation

Mr Vic McGrath, Torres Strait Regional Authority (TSRA)

Program 3 Budget Summary

	Cash	In-kind	Total
MTSRF	$393,000	-	$393,000
Other	$45,000	$399,231	$444,231
Total	**$438,000****	**$399,231**	**$837,231**

** Investment into the knowledge repatriation project is considered within Theme 5.

The Torres Strait Node comprises two sub-programs:

- Status, Trends and Use; and
- Marine Species of Conservation Concern.

Sub-program 2 covers both the Great Barrier Reef and Torres Strait nodes of MTSRF, is led by Professor Helene Marsh and is addressed under Program 4. Communications and an engagement system are shared between the two programs.

Program 3 will focus on identifying key issues in Torres Strait that should lead to the development of indicators to be incorporated into a Data Integration and Synthesis process that will assist development of environmental reporting for the Torres Strait region and incorporation into the Reef Atlas. The indicators will align with the broad 'Land and Sea Program' issues to assist management decision making through the provision of precise information on environmental condition and trends of the region. The issues and indictors described above will be identified through a process of engaging with stakeholders in Torres Strait, including Torres Strait Regional Authority Executive Members, the Community Liaison officer, and relevant management agencies. The engagement will include explanation of what has been learned from the work of CRC Torres Strait in relation to the 'health of the marine ecosystem', and facilitate dialogue about the linkages between research and management approaches in the Torres Strait region.

The intent is to then evaluate the identified key issues (and in discussion and interaction with the stakeholders of Torres Strait), with the following aims:

- To identify existing management objectives associated with them;
- To identify conceptual models of the processes surrounding those key issues;
- To identify potential indicators and thresholds of status and trends in each issue;
- To identify, prioritise and undertake the research needed to develop those indicators with thresholds of concern, limits and implied actions, and to develop systems to measure and report on them, and link them into the overall report card; and
- To contribute to the development of Data Integration and Synthesis process for reporting the ecosystem health of Torres Strait.

The primary objective of work undertaken in the first two years of the Program was to identify appropriate areas were future research is required in the Torres Strait region. Climate change, ecological assessment of wild commercial sponges, investigation of co-management for hand collectable fisheries and the repatriation of knowledge will be key areas for research in the third year of the Program.

Previous work under the Torres Strait CRC has identified the potential of bath sponge aquaculture in Torres Strait. Through this program an assessment of the distribution and abundance of wild commercial sponge species in Torres Strait, identification of elements of environmental risk (evidence of disease, sedimentation), and establishment of an ecologically sustainable strategy for seed stock harvest will be established. The outcomes from this research will provide fundamental information for the support of a sustainable bath sponge aquaculture industry.

Climate change issues in the Torres Strait region has been raised in response to the inundation events experienced on several of the islands over recent years. Climate change impacts likely to be experienced in the coming years include less predictable winds and currents that will affect traditional and commercial fishing practices, an increase in disease vectors (eg mosquitoes carrying dengue), cultural impacts from flooded heritage sites (e.g. grave yards) and reduced fresh water resources. The primary goal of this project is to establish ways to increase community resilience to environmental change in the Torres Strait Islands by integrating scientific and socio-economic assessments to develop recommendations for climate change resilience and adaptation and planning in Torres Strait.

Management agencies are interested in trialing adaptive co-management of fishery resources in the Torres Strait. The project will prototype methods of assessing the social, economic, cultural and ecological benefits resulting from co-management using the hand collectables fisheries (beche de mar and trochus) as a case study. It would also develop the role for communities to contribute to reporting initiatives being developed through program 3.

Community feedback has indicated that not all past and present research activities in the Torres Strait region have been appropriately disseminated to communities. As part of MTSRF Theme 5, a proposal has been submitted to develop appropriate format and delivery mechanisms of scientific research in the Torres Strait Islands, the information gained through this process will help the assessment of future research investment in the region.

Projects

1.3.1 Traditional knowledge systems and climate change in the Torres Strait.....$80,000

1.3.2 Ecological role and potential value of sponges to the Torres Strait $80,000

1.3.3 Livelihood benefits of co-management of hand collectable fisheries in the Torres Strait..... $80,000

1.3.4 Communication, community engagement and enhanced delivery.....$50,000

1.3.5 Data integration and synthesis for development of reports on ecosystem health in the Torres Strait region.....$103,000

PROGRAM 3: TORRES STRAIT – STATUS, USE AND TRENDS

Project 1.3.1: Traditional knowledge systems and climate change in the Torres Strait

Project Leaders and Host Organisation

Associate Professor Kevin Parnell and Dr Karen McNamara, James Cook University (JCU)

Project Team 2009/10

Title	Organisation	Role	FTE
Associate Professor Kevin Parnell	JCU	Project Leader and expert advisor – physical impacts	0.2
Dr Karen McNamara	JCU	Project leader	0.6
Dr Lisa Law	JCU	Expert advisor – socio-cultural impacts	0.1
Mr Jonathon Sibtain	JCU	Fieldwork assistant	0.4
David Hanslow	TSRA	Expert advisor – existing climate change projects in the Torres Strait	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
TSRA	Damian Miley, David Hanslow and Vic McGrath
TSIRC	Island Councillors
DEWHA	Sheryl Hedges

Project Duration

Start Date: 1 July 2009 End Date: 30 June 2010

Project / Task Objectives

In recent times, there has been a growing concern over the exposure of communities in the Torres Strait region to the impacts of climate change. These changes have not only been recorded by scientists, but they are also known of by Torres Strait Islanders through their close relationship with their islands and seas.

This project seeks to work with community people, especially Elders on a number of island communities in the Torres Strait region, documenting their experiences with climate change. These experiences will include their memories of extreme weather events and changes, seasonal patterns (including winds, wet and dry seasons) but also patterns in animal and plant life. The way Islander people have adapted to these situations in the past will also be a very important part of planning for future culturally-appropriate adaptation strategies.

In the initial planning stages, discussions were held with TSRA to ensure that the objectives of this project aligned with existing climate change projects in the Torres Strait. As a result, this project will attempt to integrate the collected traditional knowledge material across these

other projects. For example, knowledge of extreme weather events are well placed to value-add to the inundation mapping project; the traditional weather calendars could provide useful information for the sea level rise mapping project; and the adaptation strategies will offer added cultural detail to the coastal erosion mapping project.

On this last point, this project sets out to better understand past, present and future adaptability. Adaptation, in the context of climate change, is the task of modifying ecological and social systems to accommodate climate change to ensure the persistence of these systems over time. Campbell and de Wet (1999: v) define adaptation as "those actions or activities that people, individually or in groups, take in order to accommodate, cope with or benefit from the effects of climate change". Given that these Torres Strait communities have been living through and adapting to environmental changes throughout history, this project seeks to document these adaptation "actions or activities" from the past, as well as explore present and future adaptive capacity.

Through the synthesis and analysis of this knowledge, it is hoped that adaptation strategies used in the past (and present) might assist in developing future capacity. This in turn will help in reducing the overall vulnerability of these communities to direct impacts (such as increased average temperatures, changes in rainfall, extreme weather events and slow onset sea level rise) and indirect impacts of climate change (including food security and gardening, water and energy security, biosecurity, biodiversity, health, fisheries, planning and development, transport and communications infrastructure, and culture and livelihoods). For instance, existing adaptation activities might include the maintenance of nurseries and water tanks to store water, while potential future activities might involve traditional planting or alternative water supply and storage programs.

Under the MTSRF program, the research generated from this project is considered public good research that is end-user and stakeholder-driven. The stakeholders for this research project are the: (i) Torres Strait Regional Authority; (ii) Island Councillors and Island Managers; (iii) Prescribed Body Corporate; (iv) Elders in these communities; and (v) locals of these communities.

The overriding objective for this project is to collaborate with the above-mentioned stakeholders to develop a project that acknowledges, records and safeguards invaluable traditional knowledge from community Elders on a number of Torres Strait Islands. From this primary objective, there are a number of tangible outcome-driven benefits of this knowledge for better understanding climatic changes and adaptation strategies. These aims are outlined below:

- Report on how the Torres Strait is constructed (through a number of means – public opinion using a surveying instrument, policy documents and media);
- Report on local stories of extreme weather events and changes;
- Develop calendars showing seasonal patterns (winds, wet and dry seasons) and patterns in animal and plant life;
- Report on resilience and adaptation strategies to climate change; and
- Develop a detailed science synthesis report.

Project / Task Methodology

In terms of the research data to be used, this will include materials collected from the traditional knowledge interviews and synthesIsland This project will also rely heavily on ethnographic observational work, particularly in the initial project stages.

Throughout this project, Karen will talk with and digitally record Elders' knowledge of weather, seasons and adaptations to climate change. Karen will then return these recordings to the community (either as a transcript or on a disc – depending on what the community requests). If it is acceptable to the Traditional Owners, the project team would then view the footage to see whether there is knowledge of past and present environmental changes (for instance extreme weather events and local seasonal changes) and adaption strategies to climate change. Ownership of this knowledge will remain with the Traditional Owners and custodians of the land.

As mentioned previously, this project has a number of stakeholders, all of which will have a poignant role in the direction and outcomes of this project. Preliminary consultation and discussions have already occurred between the project team and TSRA to assist in setting the parameters for the project direction, questions to be asked and how this data might be used, particularly in the development of adaptation strategies to climate change.

Project Outputs / Milestones 2009/10

Objective	Targeted Activity	Completion Date
a	Collect, analyse and synthesis the traditional knowledge material (KM)	1 June 2010
b	Report on how the Torres Strait is constructed (KM)	4 January 2010
c	Report on local stories of extreme weather events and changes (KM)	30 June 2010
d	Develop calendars showing seasonal patterns and patterns in animal and plant life (KM)	30 June 2010
e	Report on resilience and adaptation strategies to climate change (KM)	30 June 2010
f	Detailed science synthesis report (KP)	30 June 2010

Project 1.3.1 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF	TSRA
Milestones		**JCU**	**JCU**
• Signing of contract	August 2009	$30,000	$20,000
• Project Leader to attend Torres Strait Steering Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Update on the project – fieldtrips, TEK collection, feedback from the islands (objectives a – d) • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable	19 October 2009	$30,000	-

For 2009/10 outputs only	Date	MTSRF	TSRA
Milestones		**JCU**	**JCU**
Report 2 submission: • Update on the project – fieldtrips, data collection, feedback from the islands (objectives a, c, d, e) (KM) • Final report from objective b (with appropriate attribution to MTSRF funding) (KM) • Outline and contents page from objective f (KP) • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable (KM)	4 January 2010	-	$25,000
Report 3 submission: • Update on the project – fieldtrips, data collection, feedback from the islands (objectives a, c, d, e) (KM) • Submission of draft report from objective f (KP) • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable (KM)	5 April 2010	$20,000	-
Report 4 submission: • Final report from objectives c, d, e (KM) and f (KP) (with appropriate attribution to MTSRF funding) • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable (KM)	30 June 2010	-	-
Total MTSRF Funding		**$80,000**	**$45,000**

Project 1.3.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$80,000	-	$80,000
TSRA	$45,000	-	$45,000
MTSRF Visual Documentation	-	-	-
JCU	-	$40,000	$40,000
Total	**$125,000**	**$40,000**	**$165,000**

JCU Project 1.3.1 Budget 2009/10

Item	MTSRF Funds	TSRA Funds	JCU In-kind	Total Cost
Salaries	$40,000	-	$20,000	$60,000
Operating	$10,000	$25,000	-	$35,000
Travel	$20,000	$10,000	-	$30,000
Communication/Extension	$5,000	$10,000	-	$15,000
Capital	$5,000	-	$20,000	$25,000
Total	**$80,000**	**$45,000**	**$40,000**	**$165,000**

PROGRAM 3: TORRES STRAIT – STATUS, USE AND TRENDS

Project 1.3.2: Ecological role and potential economic value of sponges to the Torres Strait

Project Leader and Host Organisation

Dr Steve Whalan, Australian Institute of Marine Science

Project Team 2009/10

Title	Organisation	Role	FTE
Dr. Steve Whalan	AIMS	Project leader and field work coordinator	0.5
Ms. Libby Evans-Illidge	AIMS	Uptake / transfer of project results for business planning and environmental effects assessment.	0.05
Mr. John Morris	Kailag Enterprises, Yorke Island	Project manager at Masig Island	0.2
Mr Vic McGrath	TSRA	Liasion officer	0.2

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
TSRA	Damian Miley
Kailag Enterprises, Yorke Island	Philippa Bauer

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

The project outlined builds on outputs and methodology of sponge aquaculture research (CRC Torres Strait Task 1.6) previously conducted in Torres Strait. Given awareness that the scale of the potential international market for commercial sponges may permit a venture larger than cottage industry size, it is critical to examine sustainability of the likely commercial development of a new industry in Torres Strait. This will be achieved by developing an understanding of key population dynamics of sponge communities and exploring risks and threats to sponge seed stock populations. Given the key functional roles sponges play in ecosystems knowledge of sponge population health will contribute to overall assessments concerning the status of aquatic habitats. Ecological and risk assessment information will be integrated into the relevant Data Integration and Synthesis Frameworks for Reporting on the health of Torres Strait ecosystems.

Additional objectives implemented in February 2009

Sponge aquaculture currently relies on growing out clonally produced fragments from wild donor sponges. The production of explants for grow out involves cutting and exposing surface of sponges which inturn involves a recovery stage before the sponge explants can grow. The growth and survival of sponge clonal explants within a culture environment is

therefore largely determined by the health of those explants at the time of seeding. We propose to undertake a series of experiments during the first half of 2009 to establish the effects of collection and handling of sponges (explants) on both growth and survival. The outcomes of the proposed research will add to the existing outcomes and milestones of MTSRF Project 1.3.2. and increase our understanding of practices that optimise the sustainable collection and handling of sponges before they are seeded for grow-out.

Recommended revisions to previous ARP operational plan

To date Project 1.3.2 has quantified temporal and spatial patterns associated with sponges (*Coscinoderma mathewsii*) at Masig Island. This has delivered data over three years and provides a fundamental platform to develop our understanding of key population demographic parameters. However, as a result of our population surveys it is clear that fluctuations in numbers of *C. mathewsii* exist between certain time periods, with notable reductions in numbers for November 2007. Patchy distribution patterns are well documented for sponges but to confirm if these fluctuations in *C. mathewsii* numbers are peculiar to the survey design or are indeed directed by real events (e.g. larval recruitment pulses and mortality) we propose a different approach for future surveys (i.e. commencing in the June 2009 field trip). ***Specifically, we propose to replace the random approach of assessing sponge abundance/distribution patterns to include monitoring of fixed transects for abundance estimates (objective a) with these transects including fixed quadrats to provide estimates of recruitment of sponges (objective c) thereby replacing the deployment of settlement tiles.*** We consider this change to the operational plan will build on existing data and provide greater interpretative power in the overall assessment of the population demography. Moreover, it will provide data on fluctuations in sponge populations associated with mortality (e.g. natural disturbance events, disease, senescence) and recruitment. This change in approach will compliment and add a new dimension to objectives (a) and (c). ***Importantly, it is considered essential in completing our assessment of C. mathewsii population demography.*** We expect that transects would be established in June 2009 and surveyed in November 2009 and April 2010 with a field trip time of four weeks, comprising two weeks per trip in November and April.

We further recommend that information generated to date from the recruitment tile surveys (objective c) will be greatly enhanced if some simple experiments were carried out to establish pre-settlement behaviours of *C. mathewsii* larvae. Knowledge of planktonic durations greatly facilitate information on larval dispersal capabilities and therefore connectivity, one of the objectives (objective b) of this project. It would also provide information on settlement cues implicated in larval metamorphosis (i.e. do larvae require specific substrates to settle?) and therefore recruitment to the population. ***This approach would require laboratory based aquarium facilities that would allow experimental manipulations of larval assays under controlled conditions (i.e. filtered (25 um) flow-through sea water with regulation of photoperiod and temperature***. The small size of larvae (less than 0.5 mm in length) also requires access to labs with microscopes to establish and monitor larval experiments. The facilities at Masig Island would therefore be unsuitable as a base for conducting this research. We suggest that experiments for this component be undertaken at the research aquarium facilities based at Orpheus Island Research Station, operated by James Cook University, during December 2009. Given *C. mathewsii* occurs both at Orpheus Island and Masig Island, information on larval behaviours should be relevant regardless of where the experiments take place. To establish if spawning cycles are consistent between Orpheus and Masig sponge populations we would train (employ) Torres Strait Islanders to assess the spawning cycles of *C. mathewsii* at Masig during the same period the larval work was being undertaken at Orpheus. Overall, this additional information will build on the existing data associated with connectivity (objective c) by addressing issues central to population connectivity of sessile organisms as the larval phase is the only phase that can disperse and when combined with knowledge of

hydrodynamics is largely responsible for defining geographical boundaries. Although objective (c) has identified rudimentary population genetic data and connectivity for *C. mathewsii*, the small sample sizes limits interpretation of the information on genetic structure of *C. mathewsii.* (as identified in the 2008 annual report) and data on larval dispersal capabilities would augment our interpretation of the genetic data. In addition, an overall understanding of larval settlement behaviour would provide the first step necessary to underpin future exploration of hatchery production of seed sponges, thereby increasing the sustainable management of this resource.

Key Objectives: (a-d) remain unchanged; however, we will implement an additional objective, (e), surrounding communication of results:

(a) Undertake an assessment of the distribution and abundance of wild commercial sponge species in Torres Strait, identifying elements of environmental risk (evidence of disease, sedimentation, etc.);
(b) Determine connections between sponge populations and risks in translocation;
(c) Determine patterns of sponge recruitment/mortality and the environmental risk of seed stock harvest leading to development of a sustainable seed collection strategy.
(d) Develop optimal handling guidelines to improve sponge explant growth and survival
(e) Communicate results and knowledge to Masig Island community via a public meeting. This can be coupled to coincide with the field trip planned for April 2010.

Project Outputs/Outcomes

(a) Demography assessment: Spatial and temporal data collected on *Coscinoderma mathewsii* has been instrumental in guiding sustainable protocols for collecting seed stock to establish the proposed sponge farm at Masig Island operated by Kailag Enterprises. Moreover, the data will be central to the management of this resource which has been recommended for consideration as a fishery through the hand collectable group at AFMA.
(b) Recruitment patterns for a range of marine invertebrates gathered over three years has been established for both sponges and other sessile marine invertebrates. The final data is still to be collected but information to date shows recruitment tiles are dominated by specific groups of invertebrates (Polychaetes). Recruitment of sponges, including *C. mathewsii* was low. Overall information on recruitment for sponges is conspicuously absent from the scientific literature and requires further work (as identified in change to the operational plan for 2009/10 – see above).
(c) Data on the effects of handling and collection of sponge fragments for growout is still to be determined. These experiments were deployed in late February 2009 and the results will be known following the collection of growth/survival data over March-June 2009.
(d) Public meetings at Masig Island in the final year to communicate the results and highlight the work that has been undertaken at Masig Island in relation to the proposed commercial sponge farm.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
a,b	Demography	June 2010
c	Recruitment	June 2010
d	Handling	July 2009
e	Communication of results	April 2010

Project 1.3.2 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**AIMS**
• Signing of contract		$20,000
• Project Leader to attend Torres Strait Steering Committee Meetings (three to four meetings per year).	2009/10	
Report 1 submission: • Schedule of proposed field activities and community engagement/liaison activities for year to 30 June 2010	1 Nov 2009	$20,000
Report 2 submission: One report detailing in separate segments • Findings of work conducted to date (population surveys and larval settlement and schedule of remaining field work) • All community engagement and liaison activities	15 Feb 2010	$20,000
Report 3 submission: • A final report (with attribution of MTSRF funding) detailing in separate segments: • Final demography assessment • Final recruitment and mortality findings • Final findings of larval settlement behaviours • Final findings of all field work conducted and liaison activities.	1 June 2010	$20,000
Total MTSRF Funding		**$80,000**

Project 1.3.2 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$80,000	-	$80,000
MTSRF Visual Documentation	-	-	-
AIMS	-	$96,097	$96,097
Total	**$80,000**	**$96,097**	**$176,097**

AIMS Project 1.3.2 Budget 2009/10

Item	MTSRF	AIMS – In Kind	Total Cost
Salaries	$49,764	-	$79,764
Operating	$15,236	$24,764	$40,000
Travel	$15,000	$10,000	$25,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$61,333	-
Total	**$80,000**	**$96,097**	**$176,097**

PROGRAM 3: TORRES STRAIT – STATUS, USE AND TRENDS

Project 1.3.3 Livelihood benefits of co-management of hand collectable fisheries in the Torres Strait

Project Leaders and Host Organisation

Dr James Butler, Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Dr James Butler	CSIRO	Human ecologist: community-based management	0.15
Dr Tim Skewes	CSIRO	Marine biologist	0.05
Shaun Ossinger	AFMA	Senior Fisheries Management officer	0.10*
Alifereti Tawake	JCU	Researcher	1.0
Steve Hall	TSRA	Fisheries officer – Community engagement	0.1*
Prof Helene Marsh	JCU	Ecologist	0.05*
Dr Natalie Stoeckl	JCU	Environmental economist	0.05*

* In-kind FTE allocation.

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
TSRA	Damian Miley, Vic McGrath, Steve Hall
AFMA	Annabel Jones, Shaun Ossinger
Torres Strait Islanders	TBA

Project Duration

Start Date: 1 July 2008 End Date: 30 June 2010

Project Background

The Torres Strait consists of numerous islands dominated by an Indigenous population. Livelihoods are based on marine fisheries (e.g. beche de mer, trochus, tropical rock lobster, dugong, and turtle) which are managed by the Australian Fisheries Management Authority (AFMA), Queensland Department of Environment, Resources and Mines (DERM) and the Torres Strait Regional Authority (TSRA). Systems of permits and total allowable catches are imposed on fisheries with varying degrees of compliance and efficiency. Ecological information of stock assessments is provided by CSIRO.

Following a history of contested resource management, relations between management agencies and communities are frequently strained. Communities are frustrated by the limits placed on catches and access to resources, and hence income and livelihood options. Social, economic and cultural impacts are significant, and the sustainability of fisheries is regularly questioned, resulting in prevailing conflict around resource governance.

To break this cycle, agencies are interested in trialing adaptive co-management of fishery resources using the hand collectables fisheries (beche de mer and trochus). Under this system of control of effort, catches and reporting is undertaken in partnership with local communities, and learning is used to provide feedback and adjustment to the system. Indigenous aspirations for fisheries management and livelihoods can be integrated with western science methods of catch limits and stock assessments to derive collaborative and sustainable harvest strategies. Community-based approaches could be integrated with other initiatives including the ranger programs and the development of turtle, dugong and other fishery management plans, which are due to be introduced from 2008. The project would prototype methods of assessing the social, economic, cultural and ecological benefits resulting from co-management. It would also develop the role for communities to contribute to reporting initiatives being developed through MTSRF Project 1.3.5 '*Reporting ecosystem health in the Torres Strait'*. Due to the focus on community-based management of fisheries, the project will also be closely linked to Project 1.4.2 *'Sustainable use of marine species of conservation concern'* through the involvement of Prof Helene Marsh, Dr. Natalie Stoeckl and Dr James Butler.

The project will be linked to a broader program being initiated by AFMA and CSIRO. This program includes research to assess the current size and status of trochus and beche de mer stocks using remotely sensed data, traditional fisher knowledge, biophysical models and ground-truthing.

Project / Task Objectives

This project aims to test an adaptive co-management framework approach to hand collectable fisheries in the Torres Strait. Working in a co-research framework with one or two island communities, the project will aim to follow a participatory planning approach with fisherman and management agencies to develop sustainable harvest and livelihood strategies. The project will test the success of co-management in terms of social, economic, cultural and ecological outcomes using the sustainable Livelihoods framework as part of a wider suite of CSIRO case studies in Australian and Melanesian Indigenous communities. Lessons learned and indicators developed will be applied to future co-management initiatives in the Torres Strait, including those for dugong and turtles investigated through Project 1.4.2.

Key Objectives:

(a) Identify the key processes and tools for developing adaptive co-management framework and harvest strategies for hand collectables in the Torres Strait.

(b) Identify indicators and assess the social, economic, cultural, ecological and livelihood benefits derived from adaptive co-management.

(c) Assess the adaptive co-management approach tested for future co-management initiatives in the Torres Strait.

(d) Develop community-based harvest strategies which incorporate traditional knowledge within a co-management framework.

Project Targeted Activities 2009/10

Objective	Targeted Activity	Completion Date
(a and b)	Undertake community engagement workshops to develop harvest strategies for incorporation in to the co-management framework	July 2009
(b)	Identify appropriate indicators for assessing stock status of beche de mer and trochus	December 2009
(d)	Community-based harvest strategies delivered to all stakeholders	December 2009
(b)	Identify appropriate indicators for assessing economic, social and cultural benefits of adaptive co-management of beche de mer and trochus fisheries	June 2010
(c)	Assessment of the adaptive co-management approach and its applicability for future co-management initiatives for fisheries in the Torres Strait.	June 2010
(d)	Develop and distribute communication material for communities and stakeholders	June 2010

Project 1.3.3 Milestones 2009/10

For 2008/2009 outputs only	**Date**	**MTSRF**	**MTSRF**
Milestones		**CSIRO**	**JCU**
On Signing		$9,020	$16,980
• Project Leader to attend Torres Strait Steering Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission • Report on community-based harvest strategies workshops	30 Aug 2009	$8,000	$10,000
Report 2 submission • Report on community-based harvest strategies, delivered to all stakeholders (with attribution of MTSRF funding). • Identification of appropriate indicators for assessing stock status of beche de mer and trochus within harvest strategies	31 Dec 2009	$8,000	$10,000
Final Report 3 Submission (with attribution of MTSRF funding) • Identification of appropriate indicators for assessing economic, social and cultural benefits of adaptive co-management of beche de mer and trochus fisheries • Assessment of the adaptive co-management approach and its applicability for future co-management initiatives for fisheries in the Torres Strait	10 June 2010	$8,000	$10,000
Total MTSRF Funding		**$33,020**	**$46,980**

Project 1.3.3 Budget

2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$80,000	-	$80,000
CSIRO	-	$23,061	$23,061
JCU	-	**$16,000	$16,000
TSRA	**-**	***$17,800	$17,800
Total	**$80,000**	**$56,861**	**$136861**

** In-kind salary for Prof Helene Marsh and Dr Natalie Stoeckl from linked Project 1.4.2
*** TSRA In-kind salary, accommodation and travel

CSIRO Project 1.3.3 Budget 2009/10

Item	MTSRF funds	CSIRO in-kind	Total Cost
Salaries	$24,528	-	$24,528
Travel	$5,417	-	$5,417
Operating	$3,075	-	$3,075
Capital	-	-	**-**
Institutional overheads	-	$23,061	$23,061
Total	**$33,020**	**$23,061**	**$56,081**

JCU Project 1.3.3 Budget 2009/10

Item	MTSRF funds	JCU in-kind	Total Cost
Salaries	$30,000	$16,000	$46,000
Travel	$8,000	-	$8,000
Operating	$8,980	-	$8,980
Capital	-	-	**-**
Institutional overheads	-	-	**-**
Total	**$46,980**	**$16,000**	**$62,980**

TSRA Project 1.3.3 Budget 2009/10

Item	MTSRF funds	TSRA in-kind	Total Cost
Salaries	-	$14,000	$14,000
Travel	-	$3,800	$3,800
Operating	-	-	-
Capital	-	-	**-**
Institutional overheads	-	-	**-**
Total	**-**	**$17,800**	**$17,800**

PROGRAM 3: TORRES STRAIT – STATUS, USE AND TRENDS

Project 1.3.4 Communication, community engagement and enhanced delivery

Project Leader and Host Organisation

Mr Vic McGrath, Torres Strait Regional Authority (TSRA)

Project Team 2009/10

Title	Organisation	Role	FTE
Damian Miley	TSRA	Project leader: co-ordination,	0.05
Mr Vic McGrath	TSRA	Liaison officer	0.5
Fiona Morfeu	TSRA	Assistant Liaison officer	0.5

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
TSRA Board	Yoshi Hirakawa

Project Duration

Start Date: 1 July 2008 End Date: 30 June 2010

Project Description / Task Objectives

Undertaking research in the Torres Strait requires that researchers understand and respect the culture and communication protocols of the Torres Strait region. Throughout the life of the CRC Torres Strait program, a system for researcher engagement had been developed and used, and the resulting protocols formed the basis for the communication and engagement of the current MTSRF science projects conducted in Program 3 (Torres Strait) and in Program 4 (Species of Conservation Concern).

This project in part, involves the recruitment of a Community Liaison officer which is co-funded by MTSRF and the TSRA, and based at the TSRA offices on Thursday Island. The CLO is required to work with the Manager of the Land and Sea Management Unit, TSRA in achieving contractual milestones and reporting requirements for MTSRF projects. Importantly the CLO's involvement and support for MTSRF research projects in the region will continue to ensure appropriate communication with Torres Strait Island communities and also to maintain partnerships and knowledge transfer with supporting agencies in the region.

Science delivery system: It is important that the results of research be made accessible to users. This is sometimes to be done in specialised, tailored ways as indicated above and covered by our budget for communications and engagement. However, it is increasingly desirable also to make information available using web-based delivery and similar tools. Such a system is also to be developed through Theme 5.

Project Milestones 2009/10

Objective	Targeted Activity	Date
(a)	Facilitate information dissemination program on research activities in Torres Strait through newsletter articles, visits to communities and meetings where appropriate	June 2010
(b)	Report to Reef and Rainforest Research Centre on communication activities	June 2010

Project 1.3.4 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**TSRA**
• Signing of contract		
• Project Leader to attend Torres Strait Steering Committee Meetings (three to four meetings per year).	2009/10	
Progress Report 1: • Plan of liaison and facilitation activities and communication events/products to assist MTSRF researcher activity in the Torres Strait (e.g. meetings, workshops, information flyers etc) for year to June 2010.	1 Aug 2009	$15,000
Progress Report 2: • Provide results of Communication Survey with selected TS Island communities which detail the success of MTSRF communication activities and reviews liaison activities.	15 Dec 2009	$15,000
Progress Report 3 (Final Report): • Final report on liaison activities and communication products during milestone period (15 Dec 2008 to 15 May 2009) and assessment of effectiveness and delivery against plan. • Final Report on Communication survey and Review of Liaison activities in the Torres Strait with attribution of MTSRF funding	5 June 2010	$20,000
Total MTSRF Funding		**$50,000**

Project 1.3.4 Budget

Contributing Organisation	Cash	In-kind	Total
MTSRF	$50,000	-	$50,000
TSRA	-	$120,000	$120,000
Total	**$50,000**	**$120,000**	**$170,000**

TSRA Project 1.3.4 Budget 2009/10

Item	MTSRF Funds	TSRA In-kind	Total Cost
Salaries	$40,000	$120,000	$160,000
Operating	$5,000	-	$5,000
Travel	$5,000	-	$5,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$50,000**	**$120,000**	**$170,000**

PROGRAM 3: TORRES STRAIT – STATUS, USE AND TRENDS

Project 1.3.5 Reporting ecosystem health in the Torres Strait

Project Leader and Host Organisation

Dr James Butler, Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Project Team 2009/10

Title	Organisation	Role	FTE
James Butler	CSIRO Sustainable Ecosystems	Human ecologist: community-based management	0.06
Research assistance	CSIRO		0.30
Leanne Cullen	CSIRO Sustainable Ecosystems	Human ecologicat, postdoc on linked social and ecological indicators	0.06
Roland Pitcher	CSIRO Marine and Atmospheric Research	Marine biologist	0.06
Darren Dennis	CSIRO Marine and Atmosphereis Research	Marine biologist	0.02
Damian Miley	TSRA	Local co-ordination	0.06
Vic McGrath	TSRA	Liaison officer	0.10

* FTE Contribution in-kind.

Summary Table of Research Users

Organisation	Organisational Contact
TSRA Board	Yoshi Hirakawa

Project Duration

Start Date: July 2008 End Date: 30 June 2010

Indicative Project / Task Objectives

(a) To identify key indicators in the Torres Strait and thresholds of concern for the identified indicators to be incorporated into a Data Integration and Synthesis process that will assist development of environmental reporting for the Torres Strait. The indicators will align with the broad 'Land and Sea Program' issues and will be operationalised to assist management in decision making through the provision of precise information on environmental condition and trends of the region. The MTSRF Community Liaison officer and relevant MTSRF researchers will assist in this process. The engagement will include building on the work to date on the 'health of the marine ecosystem', and facilitate dialogue about the linkages between research and management approaches in the Torres Strait region.

(b) To evaluate the identified key indicators (and in discussion and interaction with the stakeholders of Torres Strait), the following activities will occur:

- the identification of existing management objectives associated with the indicators;
- the identification of conceptual models for determining efficiency of indicators;

- the identification of potential thresholds of status and trends in each issue;
- appropriate methods of reporting information from and to communities

(c) To investigate the feasibility of establishing a network of community-based monitoring which can contribute to the development of the *e-Atlas* (MTSRF Project 1.1.5) for reporting in the Torres Strait.

Over Year 2 (2007-2008) of this project relevant ecosystem health indicators were identified. In Year 3 (2008-2009) available data for indicators considered of most relevance to Torres Strait communities have been assessed and potential thresholds of concern identified. The next stage of the project will focus on testing appropriate forms of reporting with communities, with guidance from the Torres Strait Regional Council and TSRA, including communication products. This will integrate with recent community-based monitoring initiatives (e.g. DEWHA-funded Indigenous Ranger Program, Seagrass Watch and CSIRO-AFMA hand collectables monitors), and the TSRA's Land and Sea Management Strategy, to generate a network of monitoring and reporting of ecosystem health. The opportunities for contributing these data to the *e-Atlas* (MTSRF Project 1.1.5) for reporting will also be investigated.

Project Activities

Objective	Targeted Activity	Date
(b)	Operationalise indicators into Land and Sea Program reporting framework	March 2009
(b)	Develop and test communication products for reporting natural resource management issues in the Torres Strait Region	December 2009
(c)	Feasibility of establishing a network of community-based monitoring which can contribute to the development of the *eAtlas*	June 2010

Project 1.3.5 Milestone Outputs 2009/10

For 2009/10 outputs Milestones [Reporting Responsibilities identified by institution in brackets]	Date	MTSRF CSIRO	MTSRF TSRA
Project Leader to attend Torres Strait Steering Committee Meetings (three to four meetings per year).		$20,750	$5,000
Progress Report 1: Report on development and testing of indicators and communication products with Torres Strait stakeholders	20 Sept 2009	$20,750	$5,000
Progress Report 2: Draft report on the feasibility of establishing a network of community-based monitoring which can contribute to the development of the *e Atlas*	31 March 2010	$20,750	$5,000
Progress Report 3: Final report on ecosystem health indicators and status presented in format acceptable to communities and stakeholders in the Torres Strait (with attribution of MTSRF funding).	5 June 2010	$20,750	$5,000
Total MTSRF Funding		**$83,000**	**$20,000**

Project 1.3.5 Budget

Contributing Organisation	Cash	In-kind	Total
MTSRF	$103,000	-	$103,000
MTSRF Visual Documentation*	-	-	-
CSIRO	-	$72,737	$72,737
TSRA	-	$10,000*	$10,000*
Total	**$103,000**	**$82,737**	**$185,737**

* In-kind indicative.

TSRA Project 1.3.5 Budget 2009/10

Item	MTSRF Funds	TSRA In-kind	Total Cost
Salaries	$5,000	-	$5,000
Operating	$5,000	$2,000	$7,000
Travel	$5,000	-	$6,000
Communication / Extension	$5,000	$8,000	$13,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$20,000**	**$10,000***	**$30,000**

* In-kind indicative.

CSIRO (CSE and CMAR) Project 1.3.5 Budget 2009/10

Item	MTSRF Funds	CSIRO in-kind	Total Cost
CSIRO salaries	$15,404	-	$15,404
Operating	$48,292	-	$48,292
Travel	$19,304	-	$19,304
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$76,273	$76,273
Total	**$83,000**	**$76,273**	**$159,273**

* Leanne Cullen in-kind salary.

PROGRAM 4
SPECIES AND COMMUNITIES OF CONSERVATION CONCERN

Program 4 is divided into two components: Marine species and communities of conservation concern (Projects 1.4.1 and 1.4.2), and Rainforest species and communities of conservation concern (Project 1.4.3).

Program 4 Budget Summary

	Cash	In-kind	Total
MTSRF	$520,000	-	$520,000
Other	-	$505,208	$505,208
Total	**$520,000**	**$505,208**	**$1,025,208**

MARINE SPECIES AND COMMUNITIES OF CONSERVATION CONCERN – PROJECTS 1.4.1 AND 1.4.2

Program Leader and Host Organisation

Professor Helene Marsh, James Cook University (JCU)

Budget Summary (Marine)

	Cash	In-kind	Total
MTSRF	$320,000	-	$320,000
Other	-	$348,100	$348,100
Total	**$320,000**	**$348,100**	**$668,000**

The marine component of Program 4 will generate world-class biological, social and economic research to provide reports on the condition and trends of dugongs, marine turtles and coastal dolphins that occur in the Great Barrier Reef World Heritage Area and Torres Strait and evaluate management options to improve their status. The marine component involves two Projects.

Project 1.4.1 has three tasks (a) dugong distribution and abundance, (b) sea turtle nesting success and (c) communication of the research activities in partnership with TSRA. Objective (c) will include the conduct of a workshop as a training tool and be completed in conjunction with Program 8 under the dedicated communication processes for marine related MTSRF activities. The outcomes of Project 1.4.1(a) will include: an estimate of sustainable anthropogenic harvest of dugongs for the northern GBR and Torres Strait; information on the spatial distribution of dugongs and sea turtles to inform management options; improved understanding of environmental factors influencing dugong population dynamics and the sustainability of different levels of anthropogenic mortality.

Project 1.4.1 (b) will analyse the patterns, rates and causes of sand loss from green turtle rookeries of international significance in the northern Great Barrier Reef region; and provide an assessment of remote methods of recording human visitation at remote sites of high

conservation significance. The effects of various climate change scenarios on sea turtle sex ratios and hatchling survivorship will also be assessed.

Project 1.4.2 has three main tasks (a) effects of acoustic alarms on behaviour of wildlife catch, (b) economics of Indigenous hunting and its management and (c) delivering information on marine species of conservation into data integration processes using a spatial risk assessment approach. The outcomes of Project 1.4.2 (a) will include as assessment of the capacity of acoustic alarms to minimise the bycatch of protected species in commercial gillnets without alienating these species from critical habitats, providing the data necessary for a spatial risk assessment of various management options.

Project 1.4.2 (b) will provide an assessment of the economic costs and benefits (ecological, social and health) of options for Indigenous hunting management. In addition this task will evaluate the direct contribution of customary harvesting to livelihoods and social welfare.

Project 1.4.2 (c) will use a spatial risk assessment approach and a GIS-based Decision Support System to integrate: spatial data obtained from the dugong aerial surveys; other relevant scientific data such as maps of the distribution of seagrasses; spatial information on current management arrangements; and spatial information on relevant use such as that in the logbooks of commercial fishers.

The outcomes of the this component will be of relevance to: (1) the Data Integration and Synthesis process for enabling ecosystem Report Cards to be developed, Condition and Trends, Risks and Threats to Critical Habitats Projects in the GBR Status and Trends Program; (2) Fisheries / Zoning, Fisheries, Socio Economic Indicators and Tourism Projects in the Sustainable-Use GBR Program; (3) Status and Trends, Economic Value, Integrated Reporting Project in the Torres Strait Program. The Marine Species of Conservation Concern Program will have a strong Indigenous focus and will also work closely with the Indigenous Landscapes Project in the Sustainable Use – Rainforest and Catchments Program. The Extension and Communication Project of the Marine Species of Conservation Concern Program will be developed jointly with the Sustainable-Use – GBR Program and the Torres Strait Program.

Projects

1.4.1 Condition, trends and projected futures of marine speciesof conservation concern.....$225,000

1.4.2 Sustainable use of marine species of conservation concern $95,000*

* Includes $20,000 cash contribution from the Program 3 Torres Strait.

RAINFOREST THREATENED SPECIES AND COMMUNITIES AND ECOSYSTEMS OF CONSERVATION CONCERN – PROJECT 1.4.3

Program Leader and Host Organisation

Dr Daniel Metcalfe, Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Budget Summary (Rainforests)

	Cash	In-kind	Total
MTSRF	$200,000	-	$200,000
Other	-	$157,108	$157,108
Total	**$200,000**	**$157,108**	**$357,108**

This component of Program 4 will build on the reporting of the condition and trend of threatened species and communities in the rainforest and coastal catchments of North Queensland and will identify management options to mitigate risks, and reduce threats to key threatened species, including cassowaries and arboreal marsupials, and habitat of threatened ecosystems.

The project continues to clarify the community composition of threatened lowland ecosystems and their role in terms of maintaining rare and threatened species and harbouring exotic and pest species. Key indicators of ecosystem health have been identified and the threshold of concern for these threatened species and direction of community change will continue to be assessed.

The program now links with the Rainforest Climate program to assess the likelihood of community change to threatened regional ecosystems under the agreed climate change scenarios. This work will be extended to determine the impacts of climate change on rare and threatened species. The outcomes of the Program will be delivered into the Data Integration and Synthesis process for enabling ecosystem Report Cards to be developed, Condition and Trends for the Wet Tropics World Heritage and North Queensland coastal catchments and into the Impacts of Climate on the Rainforests of North Queensland.

Projects

1.4.3 Rainforest threatened species and communities and ecosystem processes $200,000

MARINE SPECIES AND COMMUNITIES OF CONSERVATION CONCERN – PROJECT 1.4.1

Project 1.4.1 Condition trends and projected futures of marine species of conservation concern

Project Leader and Host Organisation

Dr Mark Hamann, James Cook University

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Mark Hamann	JCU	Sea Turtle ecologist: project leader Raine Is tasks manager.	0.95
Dr Col Limpus	DERM	Sea turtle ecologist: co-investigator on the Raine Is task and manage QPWS projects that link to MTSRF.	0.05
Ian Bell	DERM	Sea turtle ecologist: advice and expertise regarding North QLD marine turtles	0.03
Professor Helene Marsh	JCU	Project advisor	0.05
Dr Scott Smithers	JCU	Marine geomorphologist: co-investigator Raine Island task	0.1
Dr Kirstin Dobbs	GBRMPA	Project guidance and advice	0.03
Ms Mariana Fuentes	JCU	PhD student investigating sea turtles and climate change in the northern GBR and Torres Strait	0.25
Ms Kristen Weis	JCU	PhD student investigating issues of management of marine turtles and dugongs	0.25
Mr John Dawson	JCU	PhD student investigating reef geomorphology – including Raine Island	0.25
Indigenous counterparts	TSRA participating Indigenous communities	Local experts: expert local advice and guidance to the community based aspects of the project and towards research participants understanding local ecology, sites and customs	0.2

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
DEWHA	Donna Kwan
DERM	Col Limpus
GBRMPA	Mark Read
TSRA	Damian Miley, Frank Loban
WWF	Lydia Gibson

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This project harnesses the expertise of researchers from James Cook University and Queensland's Department of Environment and Resource Management together with Indigenous local experts to conduct world class multidisciplinary problem-focused research that will enhance the scientific information required to develop effective management strategies for the populations of marine species of conservation concern that occur in the Great Barrier Reef World Heritage Area and Torres Strait.

The priorities for MTSRF funding have been determined in consultation with the key end user groups. The research will be conducted across jurisdictions at spatial scales relevant to ecology of the focal species and to the end users of the research. Including co-investment funded tasks, the research will potentially provide reports on the condition and trends of dugongs, marine turtles and marine turtle habitats (nesting) that occur in the Great Barrier Reef World Heritage Area and Torres Strait and evaluate management options to improve the status of these species. Where links between this project and projects in other programs occur, we will ensure that collaboration with other research groups occurs to reduce duplication and maximise the research potential of both projects. Where applicable, information from this project/tasks will enable reporting and assessment of the ecosystem health of key environmental assets.

Key Objectives:

a) **Sea turtle nesting success:** To determine factors influencing nesting success of female turtles and egg survivorship of green sea turtles at Raine Island, Moulter Cay (GBR) and Murray Island (TS) and recruitment of juvenile turtles into the population;
b) **Hawksbill turtles:** Understanding the biology and status of hawksbill turtles breeding in Torres Strait;
c) **Dugong tracking:** To determine home range use of dugong around the Orman Reef system. Improve methods for studies that define habitat use and linkages between habitats; and
d) **Communication:** To communicate the results of research activities (years 1-4) and discuss/workshop relevant research and management issues in partnership with TSRA, GBRMPA and DERM.

Project / Task Methodology

Objective (a) Sea turtle nesting success: To determine factors influencing nesting success of female turtles and egg survivorship of green sea turtles at Raine Island, Moulter Cay (GBR) and Murray Island (TS) and recruitment of juvenile turtles into the population; and

Objective (b) Hawksbill turtles: Understanding the biology and status of hawksbill turtles breeding in Torres Strait

The specific aims of this project are to:

1. Determine the patterns, rates and causes of sand loss from Raine Island, Moulter Cay (GBR), Bramble Cay and Murray Island (Torres Strait);
2. Calculate reproductive parameters for nesting green turtles at Bramble Cay and Murray Island (size range, nesting success, mortality rates [of nesting turtles], egg production);
3. Determine factors influencing nesting success of green turtles;
4. Determine recruitment rates of green juvenile turtles into the population (combine genetics and laparoscope information);
5. Understanding the biology and status of hawksbill turtles in Torres Strait
6. Conduct a risk assessment of climate change (PhD – Fuentes); and
7. Investigate issues of scale in relation to marine turtle management (PhD – Weiss).

In 2009/10, the project involves conducting two concurrent trips to green turtle nesting sites and one trip per year to a green turtle foraging site. One nesting turtle trip will visit Raine Island and Moulter Cay (coordinated by QPWS) and the second trip will visit the Murray Islands in Torres Strait. The foraging turtle site will be the reefs of Torres Strait. While the foraging area trip can be held at various times of the year the trips to the nesting beaches will follow the routine established for green turtle nesting population monitoring by Queensland Parks and Wildlife Service (QPWS). At Raine Island, Moulter Cay and Murray Island ecological data on the nesting turtles will be collected using the standard collection methods of QPWS (Limpus *et al.* 2003). Environmental factors influencing egg and hatchling survivorship at each rookery will be explored using a quantifiable approach (Miller 1985; 1999). At the foraging area sites in Torres Strait, turtles will be randomly caught on the reef flats and data will be collected on size, sex and age class structure, recruitment rates and breeding rates (Limpus and Reed 1985; Hamann *et al.* 2005). At Murray Island and Bramble Cay, local Indigenous people will be trained in all aspects of the field-work (see Hamann *et al.* 2005 for examples).

In 2008 and 2009 Iama community and TSRA received funding from DEWHA to undertake a baseline survey of hawksbill turtles at Sassie Island. Sassie Island was reported in the 1980s as the major hawksbill rookery in the GBR and Torres Strait. However, access and monitoring are logistically challenging. Surveys run by Iama have found that Sassie Island is still a very important rookery for hawksbill turtles but nearly all nests are being predated. We will support Iama and TSRA to develop a monitoring project for Sassie Island to better understand the importance of the rookery with regard to nest success and biology.

We aim to develop a working partnership with QPWS, TSRA and GBRMPA to improve the science and management of northern GBR green and hawksbill turtle rookeries.

Marine turtle life history is strongly tied to environmental variables, and consequently they are vulnerable at several life stages to the predicted effects of climate change. In Project 1.4.1 (PhD – Fuentes), we will explore how the predicted impacts of climate change may

relate to marine turtles, develop a risk assessment for green turtles in the northern GBR and Torres Strait.

Management of marine turtles (and dugong) is complex and will involve several State and Commonwealth agencies and may include several management options. A PhD (Weiss) project will address issues of scale as they relate to marine turtle management.

Objective (c) Dugong tracking: We will work with the Mabuiag community to track dugong around the Orman Reef system. The project will examine home range and habitat use – specifically related to how dugong share their time between reef tops and deeper water seagrass habitat. This will be a co-investment project with JCU (grant to AMMC pending).

The dugong objective was added to inform community-based management of dugongs by involving Islanders in satellite tracking to quantify dugong movements and habitat. This information is important because (1) local information and modelling suggest that this population is currently over-harvested and (2) the comparison of spatial models of dugong hunting and relative dugong density indicates that spatial management has considerable potential as a tool to manage the Indigenous harvest of dugongs. In 2008 Management plans were developed by 8 Torres Strait communities to manage turtle and dugong. However, the development, and success, of spatial management for dugong in Torres Strait is challenging because little is known about the spatial ecology of dugong in the area.

Objective (d) Communication: Research results and development of research partnerships with communities:

- Community meetings will be run in four key locations – [Mer, Erub, Iama, Thursday Island). Meetings will be used to discuss the results of the projects, and collect ideas for future marine turtle and dugong research in the future years.
- We will support a meeting of stakeholders to discuss future Raine Island research, monitoring and management. The meeting will be run in cooperation with GBRMPA and DERM.

Project Outputs/Outcomes

Objective (a): The outcomes of the work conducted within this objective will yield:

- A final report on work undertaken over the four-year research program – including reports of fieldwork undertaken to identify aspects of nesting success and egg survivorship. The report will include a final identification and evaluation of key threats.
- An assessment of the vulnerability of green turtles in the northern GBR and TS to the impacts of climate change. This assessment will include a population based risk assessment and results of the three-year modeling project.
- An assessment of the importance of other rookeries (besides Raine Island) to the resilience of the northern GBR and TS green turtle population to climate change.

These reports and assessments will inform GBRMPA, DERM, TSRA and DEWHA in the future management of green turtles in the northern GBR and Torres Strait.

Objective (b): A baseline report on the status and biology of hawksbill turtles in Torres Strait will be prepared and then used to develop a field based monitoring program to assess the status of hawksbill turtles in Torres Strait. This will complement efforts by DERM to understand the status of hawksbill turtles breeding in the northern GBR.

The report will inform GBRMPA, DERM, TSRA and DEWHA in the future management of green and hawksbill turtles in the northern GBR and Torres Strait.

Objective (c): A report on the home range and habitat use of dugong around the Orman Reef system will be prepared. The report can inform the effectiveness of spatial closures and restrictions on night hunting as management tools. Additionally we will inform the adaptive cycle of dugong management in Torres Strait by working with Torres Strait Islanders including Traditional Owners and the Torres Strait Region Authority.

Objective (d): Objective (d) has two main components:

- Part (1) is to conduct community-based workshops in Torres Strait communities to repatriate knowledge and evaluate the project with regard to developing the Knowledge Attitudes Skills and Aspirations of participants. We will prepare a report on the workshop and the evaluation process.
- Part (2) is to support GBRMPA and DERM hold a Raine Island Stakeholder workshop in Townsville. This workshop will discuss future research, monitoring and management of Raine Island. We will report on the meeting and provide copies of minutes and other outputs.

Project Targeted Activities 2009/10

Objective	Targeted Activity	Completion Date
(a)	Turtle nesting beach surveys (Dowar, Bramble Cay)	December 2009
	Turtle foraging area trip	September 2009
	Risk assessment of climate impacts to the northern GBR population	May 2010
(b)	Turtle nesting beach surveys (Sassie) for hawksbills	February 2010
(c)	Dugong tracking	March 2010
(d)	Torres Strait information feedback meetings	May 2010
	Raine Island meeting of stakeholders	December 2009

Project Milestones 2009/10

For 2009/10 outputs only Milestones – All JCU responsibilities	Date	MTSRF JCU
Signing of contract		
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report 1 submission: • Schedule of field activities (community feedback, site visits etc.) for objectives a, b, c, d. • Proposed schedule of training events for Indigenous Torres Strait Islander participants in project. • Plan of any communication activities in partnership with stakeholders plus detail of products for 2009/10 and summary of liaison activities. (objective d)	30 Sept 2009	$50,000
Report 2 submission: • Report on activities conducted to date to meet objectives a to d (above): areas monitored, data collected, and preliminary findings (with appropriate attribution of MTSRF funding). • Summary of any meetings and workshops undertaken to date, including minutes of meetings/workshops if applicable.	11 Jan 2010	$122,000
Report 3 submission: • Draft report on field work undertaken in year four - to identify aspects of nesting success and egg survivorship (with appropriate attribution of MTSRF funding). The report will build upon results from years 1 to 3 and include a revised identification and evaluation of key threats (obj a-b). • Report on meetings and workshops including locations, participation, minutes (if taken) and outputs/outcomes	15 May 2010	$25,000
Report 4 (final report) submission: • Final report on fieldwork undertaken in year four - to report on aspects of sea turtle nesting success and egg survivorship (with appropriate attribution of MTSRF funding). The report will provide both a year 4 and whole project analysis of data and include a revised identification and evaluation of key threats (obj a) (with appropriate attribution of MTSRF funding). • Final report describing the outcomes of a population-based risk assessment of the vulnerability of green turtles in the northern GBR and TS to the impacts of climate change. This will include an assessment of importance of other rookeries (besides Raine Island) to the resilience of the northern GBR and TS green turtle population to climate change (Mariana Fuentes PhD) • Report investigating issues of scale in relation to marine turtle management (Kristen Weiss PhD) • Report on the home range and habitat use of dugong around the Orman Reef system (Objective c). • Baseline report on the status and biology of hawksbill turtles in Torres Strait (Objective b) • Final summary of communication activities undertaken through course of project and copies of communication products developed (obj d), including a list of community and stakeholder meetings, locations, participation, minutes (if taken) and outputs/outcomes. • Final report describing the outcomes of workshops in Torres	1 June 2010	$25,000

For 2009/10 outputs only	Date	MTSRF
Milestones – All JCU responsibilities		**JCU**
Strait communities to repatriate knowledge and evaluate the project with regard to developing the Knowledge Attitudes Skills and Aspirations of participants • Report from stakeholder workshop to discuss future research, monitoring and management of Raine Island • Meta-data describing all data generated within each objectives of Project 1.4.1 over the lifetime of the project uploaded into the e-Atlas.		
Total MTSRF Funding		**$222,000**

*A total of $3,000 is held by Reef and Rainforest Research Centre for Visual Documentation for this project.

Overall Project 1.4.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$222,000	-	$222,000
MTSRF Visual Documentation*	$3,000	-	$3,000
JCU	-	$115,000	$115,000
TSRA	-	$25,000	$25,000
GBRMPA	-	$60,000	$60,000
DERM	-	$46,000	$46,000
Total	**$225,000**	**$246,000**	**$471,000**

* A total of $3,000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

Project 1.4.1 Objective (a)

JCU Project 1.4.1 Objective (a) Budget 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	$96,000	$15,000	$111,000
Operating	$46,000	$15,000	$61,000
Travel	$14,000	-	$14,000
Communication / Extension*	-	-	-
Capital	-	$20,000	$20,000
Total	**$156,000**	**$50,000**	**$206,000**

TSRA Project 1.4.1 Objective (a) Budget 2009/10

Item	MTSRF Funds	TSRA In-kind	Total Cost
Salaries	-	-	-
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**$25,000**	**$25,000**

DERM Project 1.4.1 Objective (a) Budget 2009/10

Item	MTSRF Funds	DERM In-kind	Total Cost
Salaries	-	$20,000	$20,000
Operating	-	$20,000	$20,000
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**$40,000**	**$40,000**

GBRMPA Project 1.4.1 Objective (a) Budget 2009/10

Item	MTSRF Funds	GBRMPA In-kind	Total Cost
Salaries	-	$30,000	$30,000
Operating	-	-	-
Travel	-	$10,000	$10,000
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**$40,000**	**$40,000**

* Communication and extension covered in Objective (d).

Project 1.4.1 Objective (b)

JCU Project 1.4.1 Objective (b) Budget 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	-	$10,000	$10,000
Operating	$23,000	$20,000	$43,000
Travel	$3,000	$5,000	$8,000
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**$26,000**	**$35,000**	**$61,000**

TSRA Project 1.4.1 Objective (b) Budget 2009/10

Item	MTSRF Funds	TSRA In-kind	Total Cost
Salaries	-	-	-
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**TBA**	**TBA**

DERM Project 1.4.1 Objective (b) Budget 2009/10

Item	MTSRF Funds	DERM In-kind	Total Cost
Salaries	-	$5,000	$5,000
Operating	-	$1,000	$1,000
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**$6,000**	**$6,000**

* Communication and extension covered in Objective (d).

Project 1.4.1 Objective (c)

JCU Project 1.4.1 Objective (c) Budget 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	-	$10,000	$10,000
Operating	$15,000	$10,000	$25,000
Travel	$5,000	-	$5,000
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**$20,000**	**$20,000**	**$40,000**

TSRA Project 1.4.1 Objective (c) Budget 2009/10

Item	MTSRF Funds	TSRA In-kind	Total Cost
Salaries	-	-	-
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**TBA**	**TBA**

* Communication and extension covered in Objective (d).

Project 1.4.1 Objective (d)

JCU Project 1.4.1 Objective (d) Budget 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	-	$10,000	$10,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	$20,000	-	$20,000
Capital	-	-	-
Total	**$20,000**	**$10,000**	**$30,000**

TSRA Project 1.4.1 Objective (d) Budget 2009/10

Item	MTSRF Funds	TSRA In-kind	Total Cost
Salaries	-	-	-
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**TBA**	**TBA**

DERM Project 1.4.1 Objective (d) Budget 2009/10

Item	MTSRF Funds	DERM In-kind	Total Cost
Salaries	-	-	-
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**TBA**	**TBA**

GBRMPA Project 1.4.1 Objective (d) Budget 2009/10

Item	MTSRF Funds	GBRMPA In-kind	Total Cost
Salaries	-	$10,000	$10,000
Operating	-	-	-
Travel	-	$10,000	$10,000
Communication / Extension*	-	-	-
Capital	-	-	-
Total	**-**	**$20,000**	**$20,000**

MARINE SPECIES AND COMMUNITIES OF CONSERVATION CONCERN – PROJECT 1.4.2

Project 1.4.2 Sustainable use of marine species of conservation concern

Project Leader and Host Organisation

Professor Helene Marsh, James Cook University (JCU)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Prof Helene Marsh	JCU	Dugong ecologist: co-coordinator of the acoustic and economic tasks and co-supervisor of PhD students.	0.10
Dr Mike Noad	UQ	Marine mammologist: Co-supervisor of the PhD student (dolphin acoustics)	0.05
Dr Guido Parra	UQ	Dolphin expert: Co-supervisor of the PhD student (dolphin acoustics)	0.05
Dr Natalie Stoeckl	JCU	Economist: chair of supervisory team for PhD student (economic task)	0.05
Dr James Butler	CSIRO	Economist: member of supervisory team for PhD student (economic task)	0.02
PhD students*	2 x JCU	Two PhD projects (1) acoustics of cetacean and sea turtles and (2) socio-economics of turtle and dugong issues	2
Indigenous counterparts and agency staff	TSRA, GBRMPA, participating Indigenous communities	Local experts: (1) expert local advice and guidance to the community based aspects of the project and towards research participants' understanding local ecology, sites and customs; (2) expert advice on agency needs	1FTE +(made up from several people)

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Mark Read
TSRA	Vic McGrath
QPIF	Malcolm Dunning
DERM	Col Limpus
WWF	Lydia Gibson

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

This project harnesses the expertise of researchers from three research providers and three end user institutions together with Indigenous local experts to conduct world class multidisciplinary problem-focused research that will enhance the natural and social science information required to develop effective management strategies for the populations of marine species of conservation concern that occur in the Great Barrier Reef World Heritage Area and Torres Strait. The priorities for MTSRF funding have been determined in consultation with the key end user groups. The research will be conducted across jurisdictions at spatial scales relevant to ecology of the focal species and to the end users of the research. The project will provide information relevant to the sustainable use and management of marine species of conservation concern in the Great Barrier Reef World Heritage Area and Torres Strait. Where applicable, information from this project will be contributed to the e-Atlas (Project 1.1.5), using a spatial risk assessment approach.

Key Objectives

a) To evaluate the effects of acoustic alarms on behaviour of marine wildlife, with emphasis on coastal dolphins.
b) To evaluate the economic factors related to Indigenous hunting and its management.
c) To identify a series of robust and cost effective indictors of the status of the dugong in the GBRWHA and explore whether the chosen indicators could have wider application for other marine taxa of conservation concern.

Project / Task Methodology

Objective (a): To evaluate the effects of acoustic alarms on behaviour of wildlife bycatch

This task will assess the capacity of acoustic alarms to minimise the bycatch of protected species in commercial gill nets without alienating the bycatch species from critical habitats. It will involve experimental evaluation of the behavioural and acoustic response of two species of coastal dolphins to acoustic alarms. Different species of dolphins react differently to acoustic alarms and the coastal dolphins of Queensland have not been studied. A spatial risk assessment of various management options will be completed. Note: This task is the PhD of research student Alvaro Berg who commenced in mid 2006 and is scheduled to complete his PhD in mid 2010.

Objective (b): Evaluate the economic factors related to Indigenous hunting and its management

This task will apply the hybrid economy framework (customary [non-market] state and market sectors) to an investigation of the economics of the Indigenous harvest of turtles and dugongs in the Torres Strait and northern Great Barrier Reef. The task will also investigate the economic costs and benefits (including social and health benefits) of management options available within this framework including the possible role of payment for environmental services (PES). This task will be achieved by literature search, participant observation (fieldwork) with relevant Indigenous organisations managing agencies and with a small sample of Torres Strait and Northern GBR communities actively engaged in marine turtle and dugong harvesting. It will include evaluation of the direct contribution of customary harvesting to livelihoods and to social life; and examination of indirect and induced benefits from PES, and examination of costs and benefits of strategies developed by relevant communities, Indigenous organisations and managing agencies together or separately. Note: This task is the PhD of research student Aurelie De Lisle who commenced in Jan 2008 and is scheduled to complete her PhD in mid 2011. The commencement of this task was deferred

until Jan 2008 because delays in recruiting the PhD student. JCU will pay for the last year of her stipend scholarship if MTSRF extension funding is not obtained.

Objective (c): Identify a series of robust and cost effective indictors of the status of the dugong in the GBRWHA

This task will explore the potential and cost-effectiveness of various performance indictors including but not limited to the following:

1. Continuing the time series of aerial surveys and using them to detect:
   i. trends in the distribution and abundance of dugongs in the GBRWHA;
   ii. change in relative proportion of Dugong Management Units (2x2 km^2 cells used in the spatial models of Grech and Marsh 2008) at high medium and low conservation value;
   iii. change in proportions of Dugong Management Units of high medium and low conservation value ranked at high risk from human impacts based on regular reviews of the spatial data on hazards and perceptions of their relative risk; and
   iv. Update existing maps of dugong distribution and density on the e-Atlas.
2. Using data from the numbers of dead dugongs recorded by Queensland Stranding Network to detect changes in the temporal and spatial pattern in dugong mortalities and causes of death.
3. Using the data from Seagrass Watch to monitor the status of inshore dugong habitats.
4. Evaluate the power of the agreed performance indicators to detect trends based on a series of retrospective and prospective scenarios.
5. Explore which of the chosen indicators are most appropriate during a workshop with agency staff.

Project Targeted Activities 2009/10

Objective	Targeted Activity	Completion Date
(a)	Final report on evaluation of the capacity of acoustic alarms to minimise the bycatch of coastal dolphins in commercial gill nets without alienating the bycatch species from critical habitats.	June 2010
(b)	Final report on the evaluation of economic factors, including current and future economic and social drivers, related to Indigenous hunting and its management.	June 2010
(c)	Final report on the condition, trends and projected futures of dugong populations in the GBRWHA, including an evaluation of the potential and cost-effectiveness of indicators of the status of these populations.	June 2010

Project 1.4.2 Milestones 2009/10

For 2009/10 outputs only **Milestones – All JCU responsibilities. All reports to be written reports unless otherwise specified.**	Date	MTSRF JCU
Signing of contract		$20,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	
Report 1 submission: • Schedule of activities (field and desktop) in Year 4 for objectives (a), (b) and (c). • Plan of communication activities for Year 4and summary of any liaison	30 Sep 2010	$17,500
Report 2 submission: • Verbal progress report to operations committee on field and desktop work conducted to date to meet objectives (a) and (b): data collected and findings. • Update to Operations Committee of any liaison activities undertaken to date, including minutes of meetings/workshops	20 Jan 2010	-
Report 3 submission: • Draft report (with appropriate attribution of MTSRF funding) on findings of Year 4 activities in relation to objectives (a) (b) (c) including summary of field and desktop work undertaken, consultation undertaken, plan for completion in out years. • Meta-data describing all data generated by MTSRF Project 1.4.2 lodged on the e-Atlas	15 May 2010	$22,500
Report 4 submission: • Final reports (with appropriate attribution of MTSRF funding) on: (a) The evaluation of the capacity of acoustic alarms to minimise the bycatch of coastal dolphins in commercial gill nets without alienating the bycatch species from critical habitats (b) The evaluation of economic factors, including current and future economic and social drivers, related to Indigenous hunting and its management (c) The condition, trends and projected futures of dugong populations in the GBRWHA, including an evaluation of the potential and cost-effectiveness of indicators of the status of these populations	1 June 2010	$34,000
Total MTSRF Funding		**$94,000***

Project 1.4.2 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$94,000*	-	$95,000
MTSRF Visual Documentation	$1,000	-	-
JCU	-	$92,100	$92,100
CSIRO	-	$2,000	$2,000
TSRA	-	$5,000	$5,000
GBRMPA	-	$3,000	$3,000
Total	**$95,000**	**$102,100**	**$197,100**

JCU Project 1.4.2 Objective (a) Budget 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	$22,500	$6,500	$29,000
Operating	$4,000	$21,000	$25,000
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	$50,000	$50,000
Total	**$26,500**	**$77,500**	**$104,000**

JCU Project 1.4.2 Objective (b) Budget 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	$22,500	$9,000	$31,500
Operating	$20,000	$1,000	$21,000
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	$2,000	$2,000
Total	**$42,500**	**$12,000**	**$54,500**

CSIRO Project 1.4.2 Objective (b) Budget 2008/2009

Item	MTSRF Funds	CSIRO In-kind	Total Cost
Salaries	-	$2,000	$2,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	-	**$2,000**	**$2,000**

TSRA Project 1.4.2 Objective (b) Budget 2008/2009

Item	MTSRF Funds	TSRA In-kind	Total Cost
Salaries	-	$5,000	$5,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension*	-	-	-
Capital	-	-	-
Total	-	**$5,000**	**$5,000**

JCU Project 1.4.2 Objective (c) Budget 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	$18,000	$2,600	$20,600
Operating	$3,000	-	$3,000
Travel	$4,000	-	$4,000
Communication / Extension	-	-	-
Capital	-	**-**	-
Total	**$25,000**	**$2,600**	**$27,600**

GBRMPA Project 1.4.2 Objective (c) Budget 2008/2009

Item	MTSRF Funds	GBRMPA In-kind	Total Cost
Salaries	-	$3,000	$3,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Total	-	**$3,000**	**$3,000**

RAINFOREST THREATENED SPECIES AND COMMUNITIES AND ECOSYSTEMS OF CONSERVATION CONCERN – PROJECT 1.4.3

Project 1.4.3: Rainforest threatened species and communities and ecosystem processes

Project Leader and Host Organisation

Dr Dan Metcalfe, CSIRO

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Daniel Metcalfe	CSIRO	Senior Research Scientist; Project leader	0.24
Assoc Prof Andrew Krockenberger	JCU	Animal physiology; sub-project leader	0.25
Dr David Westcott	CSIRO	Vertebrate ecology	0.05
Matt Bradford	CSIRO	Plant ecology technical support	0.23
Andrew Ford	CSIRO	Plant ecology technical support	0.25
Caroline Bruce	CSIRO	Data analysis technical support	0.05
Tina Lawson	CSIRO	Spatial analysis technical support	0.20
Adam McKeown	CSIRO	Vertebrate ecology technical support	0.10

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Steve Goosem
Alliance for Sustainable Tourism	Melinda Connolly
Terrain NRM	Allan Dale
QEPA (Threatened Species Unit)	Peter Young

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This project will identify the condition and trend of, and likely future for, cassowaries and arboreal mammals and the rare and threatened species and ecosystems of the coastal lowlands, with an initial focus on the Tully-Murray-Hull catchments which include some of the best remnant *Melaleucas* in the bioregion, and the important Mission Beach area. It will also develop management options for mitigating threats to these environmental assets. Surveys to report condition and trend will be agreed through discussion with end users and in a workshop to ensure that the maximum utility may be achieved from the survey effort, and to ensure that data collection meets individual requirements for statutory reporting and to support other projects (see Tables 1 and 2). Data on Regional Ecosystem composition and condition will support the QEPA re-assessment program; identified threats and condition will feed into Terrain NRM Ltd and WTMA statutory reporting, and inform policy development, and collation of information on the impact of fire and of weeds and feral animals will inform QPWS management policy and QDNRMandW weed eradication programs. One consequence of the range of Research Users with an interest in the outputs of the project is that the data needs to be collected and analysed in a manner suitable to providing outputs at a range of scales and to a range of different types of research user. Outputs from climate change related objectives will assist managers to critically assess realistic and mechanistic-based climate change threats to two groups of Wet Tropics endemic vertebrates, the microhylid frogs and rainforest possums, allowing identification of likely refugia and possible mitigation measures. The project involves substantial collaboration with Terrain NRM Ltd and links into the work being undertaken through the Coastal Catchment Initiatives program in the Tully catchment and potentially, in subsequent years, in the Barron catchment.

Key Objectives:

(a) Refinement of existing survey protocols for birds and vascular plants to incorporate flying foxes, signs of fire history, presence and abundance of weeds and ferals, and expand data collection on cassowaries and on ecosystem health [*refinements completed; ongoing focus on data collection on cassowary population structure and viability*].

(b) Completion of baseline data for the Tully-Murray-Hull catchments using revised protocol, and collection of baseline for other priority catchments [*completed for Tully-Murray-Hull and Johnstone catchments*].

(c) Clarification of the community composition of threatened lowland Regional Ecosystems (REs) and their role in terms of maintaining rare and threatened species, and harbouring exotic and pest species. Identification of key indicators of ecosystem health [*broadly completed, but ongoing surveys are still contributing new records, and surveys continuing in conjunction with Project 1.2.1 and in collaboration with parallel Regional Ecosystem revisions being undertaken by QEPA Herbarium, Townsville are being targeted at EPBC-listed communities*].

(d) Assessment of key threatening processes and of effectiveness of current management practices in maintaining lowland ecosystem health [*key processes identified in year 1, and ongoing work is identifying examples of good practice. Final report on current management practices incorporated into outputs for 2009/10. Specific threats being assessed for impact include presence and abundance of weeds and ferals (with Project 2.6.2), effects of fragmentation (see objective e) and predicted impact of various climate change scenarios (see objective f)*].

(e) Focus on the impact of fragmentation as a key threatening process toward which targeted management approaches may have significant outcomes; contextualisation of fragments in terms of their size, location and age, and the biological trajectories that different combinations of these may confer [*key project focus for 2008/09, finalised reporting in 2009/10*].

(f) Assessment of likelihood and direction of community change of REs under climate change scenarios, or as a result of changed ecological functioning (linked to 2.5ii.3) [*initial directions reported and assessment of impacts of climate change completed in 2008/09; implications developed in 2009/10*].

(g) Determine physiological mechanisms of impacts of climate change on highland rare and threatened species concentrating on arboreal marsupials and microhylid frogs (linked to 2.5ii.4) [continued focus for JCU in 2008/09, and linked to ongoing progress and funding in Project 2.5ii.4].

Project / Task Methodology

Objectives (a)-(e): Refinement of existing survey protocols for birds and vascular plants to incorporate flying foxes, signs of fire history, presence and abundance of weeds and ferals, and expand data collection on cassowaries and on ecosystem health; and completion of baseline surveys

Existing CSIRO and QEPA CORVEG survey methodologies and datasets will be merged and supplemented with specific tasks to generate data on identified species and on management issues. Two proformas will be produced, a detailed one for use by survey teams working primarily on the MTSRF project, and a more general one to supplement survey work carried out by end users but with a specific focus on another aspect, such as weed distribution. Selection of survey sites in Tully-Murray-Hull catchments with involve agreement with stakeholders on survey site selection and prioritization, both for targeted surveys and non-targeted surveys which yield additional data from other management work. Collection of additional data for pre-surveyed sites, and completion of additional sites to generate baseline data for the Tully – Murray – Hull catchments, will follow. Statistical and spatial analysis of data will include (i) comparison of plant inventories with published RE classifications (in collaboration with QEPA), (ii) assessment of weed and feral invasion and load in fragments of different sizes and after various damage levels due to cyclone Larry (with QDNRMandW and Terrain NRM and FNQ ROC), (iii) impacts of past and current management practices on maintaining biodiversity and ecosystem integrity (with QPWS and WTMA). Biodiversity analysis and prediction of habitat use by key species, notably cassowaries and mahogany gliders, will be carried out using process modelling where data allows. Threatened species and communities will be identified using current statutory listings, expert opinion and consultation with local Indigenous groups. A review of a range of existing models with respect to highlighting potential indicators of habitat condition will be carried out. Regular reporting to stakeholders and workshops with end users will ensure that the research direction remains close to the end users' requirements. Engagement with local Indigenous groups, where possible, will ensure that cross-cultural concepts of threat are also considered.

The first year of this project focussed on defining the approach to achieving the desired outcomes, in particular agreeing on a focal area on which to concentrate all resources in order to achieve better resolution of the questions at hand. To this end the coastal lowlands of the Tully/Hull, Murray and South Johnstone catchments were selected, and baseline data for the rainforest communities assembled. Whilst all appropriate threatening processes will be considered, the focus in years 2-4 will be primarily on the impacts and consequences of fragmentation of lowland communities, with the fate of threatened and iconic species, the impacts of weeds and ferals, and on other human-mediated impacts considered within that context. These impacts may include the effects of tourism in highly visited areas around Mission Beach (focus of Project 4.9.6) and some parts of Edmund Kennedy National Park. Fragments will be studied in the context of their size, their isolation and their age, and will range from tiny blocks in the corner of cane paddocks to extensive natural areas such as the Mt Mackay and Mission Beach communities. Surveys will continue to document plant species and avian diversity, measures of ecosystem health, and the presence or signs of

threatened or feral animals. Established collaborative links with the QEPA will see the incorporation of specific work targeted at the assessment of habitat quality and fragmentation of EPBC-listed habitat, or habitat supporting EPBC-listed species, and on determining the lessons to be learned from cyclone Larry in terms of the need to prioritise restoration and corridor plantings in areas where they will have most impact.

Objectives (f)-(g): Mechanisms of climate change impact on threatened species

Two groups of Wet Tropics endemic vertebrates have been selected as highly likely to be threatened by the effects of climate change- microhylid frogs and marsupial folivores. Objective (f) is designed to determine the role of physiological tolerances in limiting the range of these groups and to use those tolerances to improve/redefine distributional models that can be used to predict impacts of climate change. The approach is twofold, first to extend a model of thermal limitation developed for the green ringtail possum. The model of distributional limitation by thermal extremes will be extended from that developed for the green ringtail possum to include the Lemuroid ringtail possum and the Herbert River ringtail possum. This will require parameterisation of the model for the new species, including the role of the den as a thermal refuge. Secondly, to develop models of physiological limitation of microhylid frogs based on oviposition/incubation, as well as adult overwintering requirements. Physical/microclimate parameters of microhylid frog distribution and oviposition sites will be determined and relevant aspects of the physiological tolerances of eggs/adult microhylid frogs will be determined across that range of environments. In both cases, selected study sites will be designed to maximise divergence within the range of restricted and widespread microhylid frog species, Lemuroid and Herbert river ringtail possums, so that models are based on the range of physiological characteristics displayed within the species.

The distributional models for highland arboreal marsupials and microhylid frogs will be altered/redefined using physiological tolerances determined during the project and used to model the effects of varied climate change scenarios on distributions and identify refugia.

Project Outputs/Outcomes

(a) Survey protocols for birds and vascular plants completed and are being used in collection of data for (b) below.

(b) Data collection completed and either used in subsequent objectives or disseminated to allied projects as outlined in Table 1.

(c) Documentation of the community composition of lowland rainforest REs, with the data shared with QEPA and WTMA. Collaborative work with QEPA herbarium to re-define some REs, particularly those on basalt substrates, and with Terrain NRM to identify EPBC-listed Coastal Rain Forest and Vine Thicket communities

(d) Report detailing our assessment of key threatening processes and of effectiveness of current management practices in maintaining lowland ecosystem, with suggestions for alternative or complimentary approaches based on analysis of collected data.

(e) Final report on effects of fragmentation and associated threats to native wildlife in a spatial and temporal context. This will build on CSIRO work in parallel projects and provide indications of the decline trajectories of fragments in different spatial and temporal contexts.

(f) Assessment of likelihood and direction of community change of REs under climate change scenarios reported and prepared for publication, with a focus on the impacts of climate change scenarios on corridor planning.

(g) Determine physiological mechanisms of impacts of climate change on highland rare and threatened species concentrating on arboreal marsupials and microhylid frogs (linked to 2.5ii.4).

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(c)	Survey fieldwork and ground-truthing of models	June 2010
(d), (e), (f)	Analysis of threats and trajectories, workshops and reporting	June 2010
(c), (d), (e), (f)	Provide geo-referenced data to MTSRF 1.2.1 and 2.6.2, to FNQ NRM, WTMA, QEPA and QPWS Threatened Species Unit	June 2010
(e)	Final report on effects of fragmentation and associated threats to native wildlife in a spatial and temporal context	June 2010
(d), (f)	Development of guidelines, with Research Users, for prioritisation and site selection criteria for restoration and corridor planting for the express purposes of maintaining population viability of key threatened assets	June 2010
(d)	Final report on current management practices incorporated into outputs for 2009/10	June 2010
(f)	Climate change implications developed	June 2010
(g)	Continued measures of thermal tolerance and microclimatic measures of habitat in microhylid frogs	December 2008-March 2009
(g)	Initial development of conceptual model of physiological limitation of microhylid frogs and ringtail possums	June 2009
(g)	Final measurements of metabolic responses to temperature in Lemuroid and Herbert River ringtail possums	July- December 2009
(g)	Final measures of thermal tolerance, water loss and microclimatic measures of habitat in microhylid frogs	December 2009-March 2010
(g)	Extension of conceptual model into spatial model of of physiological limitation of microhylid frogs and ringtail possums	2010
(g)	Model effects of varied climate change scenarios on distribution of microhylid frogs and rainforest ringtail possums	2010

Project 1.4.3 Milestone Payments 2009/10

For 2009/10 outputs only **Milestones**	Date	MTSRF CSIRO	MTSRF JCU
Signing of contract		$35,000	$10,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
• Written report detailing progress on remaining objectives, with particular reference to completion of lowland basalt rain forest mapping, and impacts of climate change.	15 Nov 2009	$35,000	$10,000
• Verbal report to Operations Committee detailing progress on remaining objectives, with particular reference to the fragment decline report	15 Feb 2010	$35,000	$10,000
Written report on completion of all objectives inclusive of: • Final report on effects of fragmentation and associated threats to native wildlife in a spatial and temporal context • Development of guidelines, with Research Users, for prioritisation and site selection criteria for restoration and corridor planting for the express purposes of maintaining population viability of key threatened assets • Final report on current management practices incorporated into outputs for 2009/10 • Climate change implications developed • All end products/reports to include attribution of MTSRF funding	5 June 2010	$42,750	$19,250
Total MTSRF Funding		**$147,750**	**$49,250**

* Total includes money held for Visual Documentation.

Project 1.4.3 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In kind	Total
MTSRF	$197,000	-	$197,000
MTSRF Visual Documentation*	$3,000	-	$3,000
CSIRO	-	$110,108	$110,108
JCU	-	$47,000	$47,000
Total	**$200,000**	**$157,108**	**$357,108**

* A total of $3,000 is held by Reef and Rainforest Research Centre for Visual Documentation for this project (see Theme 5).

CSIRO Project 1.4.3 Budget 2009/10

Item	MTSRF	CSIRO – In Kind	Total Cost
Salaries	$117,750	-	$117,750
Operating	$15,000	-	$15,000
Travel	$15,000	-	$15,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$110,108	$110,108
Total	**$147,750**	**$110,108**	**$257,858**

JCU Project 1.4.3 Budget 2009/10

Item	MTSRF	JCU – In Kind	Total Cost
Salaries	$31,850 (0.65 FTE RA)	$47,000 (In-kind 0.25 FTE)	$78,850
Operating	$6,700	-	$6,700
Travel	$10,700	-	$10,700
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$49,250**	**$47,000**	**$96,250**

Table 1: Summary of existing and proposed linkages between MTSRF Project 1.4.3 and other MTSRF projects.

MTSRF Project	Data Delivery or Other Linkage
1.2.1: Status and trends of biodiversity	Geospatially referenced data from field surveys provided to compliment gap filling efforts; equivalent sharing of 1.2.1 refugial area surveys where appropriate
2.5ii.3: Understanding climate change threat to ecosystems and ecological processes	Two lowland climate change plots at in the South Johnstone catchment provided to 1.4.3 as species and abundance data; climate models developed at a regional scale applied to local catchments
2.6.2: Identification and impact of invasive pests in the Wet Tropics Rainforest	All non-native plant species, and signs or sightings of feral animals, geospatially referenced and passed to Project 2.6.2
4.9.3: Impacts of urbanisation on North Queensland environments: management and remediation	Regular meetings with project team to ensure fragment survey methods are compatible, and to align conservation prioritisation approaches
4.9.4: Integrating ecology, economics and people in forest and landscapes	Maintain regular contact to ensure that biodiversity values of timber plantations in lowland contexts are communicated, and ensure that the values of native hardwood plantations are appropriately recognized in determining landscape connectivity
4.9.5: Restoring tropical forest landscapes	Regular meetings with project team to ensure fragment survey methods are compatible, and to align conservation prioritisation approaches. Input data from surveys of revegetation projects into 4.9.5 to inform success of restoration plantings, and receive information back regarding best management practice for restoration plantings
4.9.6: Strategic Natural Resource Management and land use planning	Regular meetings with project team to ensure fragment classification and corridor planning approaches are aligned. Exchange of reports detailing recommendations to ensure that the Mission Beach focus area matches with the larger Tully/Murray/South Johnstone area.

Table 2: Summary of existing and proposed linkages between MTSRF Project 1.4.3 and external Research Users.

Research Users external to MTSRF	Data, interpretation and other products
WTMA	Identification of status of key rainforest communities and a number of legislatively defined threatened species outside the WTWHA, together with an assessment of their long term viability. Listing of key threatening processes, their relative impact on fragmented native vegetation, and potential thresholds of concern. [Ongoing contact and liaison between project team and key WTMA staff over issues as they develop. Discussions in 2009/10 likely to include potential revisions to classification of some vegetation types, role of fire, and importance of WHA for preserving significant evolutionary history in its flora. Ongoing collaboration with WTMA and Project 1.2.1 on weeds and ferals mapping.]
Queensland EPA	Complimentary rain forest surveys using a broadly similar methodology to compliment CORVEG surveys to be carried out in the lowland woodlands in 2009/10. Exchange of data and measures of habitat condition. Ongoing advice regarding fire and impacts on ecology of mahogany gliders, and on monitoring of cassowary populations. [Initial co-located surveys to ensure parity of approaches and results carried out in 2007-08; rain forest surveys carried out with jointly-agreed protocol, and data fed back (a) through significant collections lodged at the Queensland Herbarium, (b) through data submissions to ParkInfo, (c) through focused reports to Regional Ecosystem mapping unit in Townsville.]
Terrain NRM	Identification of habitat quality, condition and trend in the light of identified threatening processes. Assessment of prioritization approaches for habitat remediation. Documentation of distributions of all non-native plant species, and signs or sightings of feral animals. [Data provided via Project 1.2.1.]
Private landholders	Identification of condition, trend and value of specific fragments. Spatial location and infestation information for all non-native plant species encountered for which landholders have statutory responsibility for control. [Ongoing feedback of data collected and the significance of the presence of particular species or communities, either because of their biodiversity values or of potentially deleterious effects.]
Local councils	Identification of condition, trend and value of specific fragments. Spatial location and infestation information for all non-native plant species encountered for which local government has statutory responsibility for control. [Ongoing data sharing as new information is collected.]
Biosecurity Queensland	Distribution and location of all class 1 non-native plant species, and signs or sightings of listed feral animals for which the State organizations have statutory control requirements. [Ongoing data sharing as new information is collected.]

THEME 2
RISKS AND THREATS TO THE ECOSYSTEMS: UNDERSTANDING CAUSES, IMPACTS AND MITIGATION OPTIONS FOR SPECIFIC THREATS, AND UNDERSTANDING AND MEASURING THE UNDERPINNING FACTORS SUPPORTING RESILIENCE

Early identification of risks and threats to North Queensland's key environment assets and early advice on options to mitigate and better manage threats, are critical to the future environmental, economic and social underpinning of North Queensland. In particular, options for promoting adaptation to climate change, increased climate variability and mitigation of the impacts of invasive species have been identified as key priorities for North Queensland. It is anticipated that research results will be dealing with prediction of impacts, sources of resilience and importantly, practical responses to threats and their mitigation.

Theme 2 Budget Summary

Program	Title	MTSRF	Other Cash	In-kind	Total
Program 5i	Climate Change – Marine	$580,000	$109,576	$1,170,823	$1,860,399
Program 5ii	Climate Change – Rainforests	$520,000	$25,000	$1,104,318	$1,649,318
Program 6	Invasive Species	$250,000	-	$250,763	$500,763
Total		**$1,350,000**	**$134,576**	**$2,525,904**	**$4,010,480**

The total value of Theme 2 is $4,010,480.

PROGRAM 5
CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION

Program 5 consists of two main components: Climate change impacts in the Great Barrier Reef (Program 5i) and Climate change impacts in Wet Tropics rainforests and adjoining catchments (Program 5ii).

Program 5 Budget Summary

	Cash	In-kind	Total
MTSRF	$1,150,000	-	$1,150,000
Other	$99,574	$2,312,232	$2,411,806
Total	**$1,249,574**	**$2,312,232**	**$3,561,806**

PROGRAM 5I: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE GREAT BARRIER REEF

Program Leader and Host Organisation

Dr Julian Caley, Australian Institute of Marine Science (AIMS)

Budget Summary (Great Barrier Reef)

	Cash	In-kind	Total
MTSRF	$580,000	-	$580,000
Other	$74,576	$1,169,323	$1,243,899
Total	**$654,576**	**$1,169,323**	**$1,823,899**

Climate change is one of the most significant threats to the sustainable use of coral reefs in Australia and worldwide (IPCC 2001). The Climate Change – Marine Program addresses specific information gaps of direct relevance and importance to users of the Great Barrier Reef and those charged with its sustainable management. This program addresses high priority issues for climate change impacts on the Great Barrier Reef:

- Regional climate change scenarios – evaluating possible futures for the GBR ecosystem on the basis of our present knowledge and forecast climate changes;
- Early Warning and Assessment System for thermal stress on the Great Barrier Reef;
- Resilience of coral reef ecosystems to climate change;
- Tools to support resilience-based management in the face of climate change.

Understanding the potential impacts of climate change on the Great Barrier Reef and management options for promoting adaptation and minimising, and remediating its impacts is critical to the long-term sustainable use of this valuable natural asset. This program describes a large-scale, integrated approach for understanding how environmental conditions will change in the near future, how these changes will impact the species that make up the reef, how resilient these species are likely to be to such impacts, and what are the best management options for minimising the risks of climate change to these reef communities.

Expected outcomes from this program will include greatly improved understanding of the links between atmospheric and oceanic conditions on the hydrodynamics around reefs at small spatial scales. These models will facilitate better understanding of how climate change will change water circulation patterns and how such changes will affect the environmental conditions faced by the organisms living on these reefs. Linked to these models will be the development of an early warning system for coral bleaching. To deliver this objective, further research will be done to better define the tolerances of corals to increasing water temperatures, how these might vary, and how the impact of changing hydrodynamics might affect other species such as seabirds. This information will then be fed into research about how well these reef systems might be able to cope with the impacts of climate change.

How best to use this information in a management context will be the focus of the fourth project which will concentrate on developing an atlas of climate change risk including socio-economic risks and building tools for prioritising management responses. To ensure the relevance of this research program to end users, end user representatives were consulted extensively throughout the development of this program. To ensure ongoing relevance, end

user representatives are included within the program teams. Further value and synergies will be derived from the close integration of this program with the Climate Change: Rainforest, Sustainable Use, Status and Trends and Synthesis and Integration programs.

Projects

2.5i.1 Hydrodynamics at the whole-of-GBR scale.....$125,000

2.5i.2 Early warning and assessment system for thermal stress on the Great Barrier Reef $200,000

2.5i.3 Resilience to climate change $150,000

2.5i.4 Tools to support resilience-based management in the face of climate change.....$105,000

PROGRAM 5II: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF RAINFORESTS AND CATCHMENTS

Project Leader and Host Organisation

Professor Steve Turton, James Cook University (JCU)

Budget Summary (Rainforest and catchments)

	Cash	In-kind	Total
MTSRF	$520,000	-	$520,000
Other	$25,000	$1,104,318	$1,129,318
Total	**$545,000**	**$1,104,318**	**$1,649,318**

Climate change is one of the most significant threats to global biodiversity and human well-being. Global biodiversity is concentrated in the tropics, with high levels of endemism in regions such as the Wet Tropics World Heritage Area of Queensland. However, what is very unclear is how climate change will impact at the regional level.

This program continues to focus on delivering strategic knowledge on the impact that climate change is having and will have on North Queensland's tropical forests, and management options for how to mitigate against the negative impacts. It will provide early identification of the risks and threats posed by climate change to North Queensland's key terrestrial environmental assets and early advice on options to mitigate and better manage these threats and reduce the risks. It will also provide advice on the resilience or lack of resilience of different terrestrial ecosystems and biodiversity.

The Program continues to develop improved regional scenarios and understanding of future climate change relevant to North Queensland's tropical forests, such as increased temperature in mountainous areas, changes in patterns of rainfall, clouds, extreme weather events and CO_2 dynamics and develop landscape-level indicators for ecosystem response to climate change. Assessment of the potential of Wet Tropics vertebrates to adapt to predicted future climatic changes and predict the risk of extinction through climate change continues to identify how, at the local level, plant communities and the biodiversity associated with them respond to current climate variability in terms of water stress, flowering and fruiting, carbon use and storage; and scaling-up from these data to provide regional scenarios. Finally the program will produce regional maps (projected to temporal scales of relevance to management) outlining likely changes to North Queensland ecosystems given a variety of scenarios for future warming, responses of biota and management interventions. These data sets will be integrated into the e-Atlas which will enable managers and industry to access spatially explicit information on the status and trends of the Wet Tropics through a single data repository.

Projects

2.5ii.1 Regional climate projections for tropical rainforests $100,000

2.5ii.2 Climate change: scaling from trees to ecosystems..... $120,000

2.5ii.3 Understanding climate change threat to ecosystems and ecological processes..... $150,000

2.5ii.4 Impacts of climate change on biodiversity..... $150,000

PROGRAM 5I: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE GREAT BARRIER REEF

Project 2.5i.1: Hydrodynamics at the whole-of-GBR scale TO BE FINALISED

Project Leader and Host Organisation

Dr Richard Brinkman, Australian Institute of Marine Science (AIMS)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Dr Richard Brinkman	AIMS	Project Leader	0.05
Dr Michael Herzfeld	CMAR	Senior Hydrodynamic Modeller	0.15
Mr Farhan Rizwi	CMAR	Programming and development of tools for model preparation and diagnostics; porting of model to other architecture	0.15
Mr John Andrewartha	CMAR	Grid preparation, preparation of forcing files.	0.15
Mr Craig Steinberg	AIMS	Integration of modelling and observational studies	0.15
To be advised	AIMS	Modeller – productions runs under guidance from Senior Modeller. Sub-grid scale parameterization experiments	1.0

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Hugh Yorkston, Laurence McCook, David Wachenfeld
DEWHA	Kevin Gale
Reef Water Quality Partnership (successor)	Rachel Eberhard
Terrain NRM	Allan Dale
Burdekin Dry Tropics NRM	Ian Dight, Diana O'Donnell, Rachel Allan
Reef Catchments Mackay Whitsunday NRM	Carl Mitchell
Fitzroy Basin Association NRM	Nathan Johnson
Queensland Canegrowers	Matt Kealley
EPA	David Scheltinga
WWF	Nick Heath, Piet Filet

Project Duration

Start Date: 1 October 2009 End Date: 30 June 2010

(A second project schedule will be developed for the period 1 July 2010 to 31 May 2011)

Project Description

Hydrodynamic models simulate the advection and mixing of water, processes fundamental in controlling the fate and impact of freshwater, sediment, nutrients and pesticides delivered from catchments in to the receiving waters of the GBR lagoon. We believe the modeling community is currently in a position where it is feasible to develop a whole-of-GBR hydrodynamic model that includes all of the important factors affecting currents, mixing, temperature and salinity within the GBR Lagoon and exchanges with the adjacent Coral Sea.

We propose to develop a whole-of-GBR three-dimensional baroclinic hydrodynamic model (GBR model) at a spatial resolution of approximately 1-2 km, with accurate boundary forcing for offshore ocean boundaries provided by a global, data-assimilating, eddy-resolving model. Such a model will underpin the future development of other essential components of a Large-Scale Water Quality (LSWQ) model, primarily sediment dynamics and biogeochemical models, and provide a capability to support the prediction and analysis of connectivity and exchange of material, including larvae, throughout the GBR.

At this spatial resolution of ~ 1-2 km, a critical challenge will be to deal with the range of spatial scales encountered within the model domain, in particular the need to resolve effects of reefs and reef passages at scales of less than the model resolution. In order to meet this challenge, an important part of this project will involve an investigation and assessment of the necessity and suitability of sub-grid parameterization schemes within a model of this spatial resolution.

As a proof of concept for a full, three-dimensional hydrodynamic model of the GBR, we will use the model developed in this project to hindcast the circulation within the GBR lagoon during the 2009 wet season, including prediction of the trajectories and spatial distribution of major freshwater inflows during this period.

Project/Task Objectives

1. To develop a whole-of-GBR three-dimensional baroclinic hydrodynamic model, at a resolution capable of capturing the key oceanographic processes impacting the GBR. This model is a necessary precursor to the development of sediment dynamics and biogeochemical components of a whole-of-GBR Water Quality Model.
2. To demonstrate proof of concept of a whole-of-GBR model through the simulation of the circulation within the GBR lagoon during a significant wet season, including prediction of the trajectories and spatial distribution of major freshwater inflows during this period.
3. To assess the suitability of sub-grid parameterization schemes appropriate for application within finite difference models GBR model.

Project Methodology

We propose to develop a whole-of-GBR three-dimensional baroclinic hydrodynamic model through a nested implementation of the finite difference model SHOC at a spatial resolution of ~1 km for the continental shelf regions of the GBR. The development of this model will build on knowledge and experience generated from the current MTSRF climate downscaling project (MTSRF Project 2.5i.1) which has implemented SHOC on the GBR at a grid resolution of between two and five kilometres from Fraser Island to the Daintree.

For this project, the nesting strategy will involve a 4 km regional grid covering the GBR section of the continental shelf from Moreton Bay to the mainland of Papua New Guinea, extending eastwards into the Coral Sea Territories a sufficient distance to avoid the topographical complexities of the Queensland and Marion plateaus (see Figure 1). Within

this regional grid, a finer one-kilometre resolution model will be nested to cover the continental shelf areas. Accurate forcing data for the offshore ocean boundaries of the regional grid will be provided by the data-assimilating eddy-resolving models of the BlueLink initiative. The vertical resolution of the model will vary with depth, but will have approximately fifty vertical layers, with sub-metre resolution near the surface.

Once established, the models will be run using contemporary ocean and atmospheric forcing and all available river inflow data for catchments draining into the GBR. Limited model validation will be undertaken utilising ocean current and temperature data from the GBR Ocean Observing System (GBROOS) and available remote sensing imagery. The nested suite of models will be used to perform a preliminary hindcast of the 2009 wet season to simulate the circulation within the GBR lagoon, including prediction of the trajectories and spatial distribution of major freshwater inflows during this period.

A critical challenge for this project will be to deal with the range of spatial scales encountered within the model domain, in particular the need to resolve effects of reefs and reef passages at scales of less than the model resolution. Correctly incorporating the contribution of sub-grid scale processes is crucial for accurate simulation of the hydrodynamics, for example providing correct exchanges through dense outer-shelf reef matrices, and also for subsequent components of the LSWQ model, such as the biogeochemical consequences of enhanced residence times for water trapped within a reef boundary layer. This challenge will be addressed through the application of high-resolution implementations numerical models to resolve these effects, applied to both simplified test cases for which analytical solutions exist and 'real-world' examples. This approach will allow an assessment of suitability of sub-grid parameterisation schemes for future incorporation into the whole of reef model.

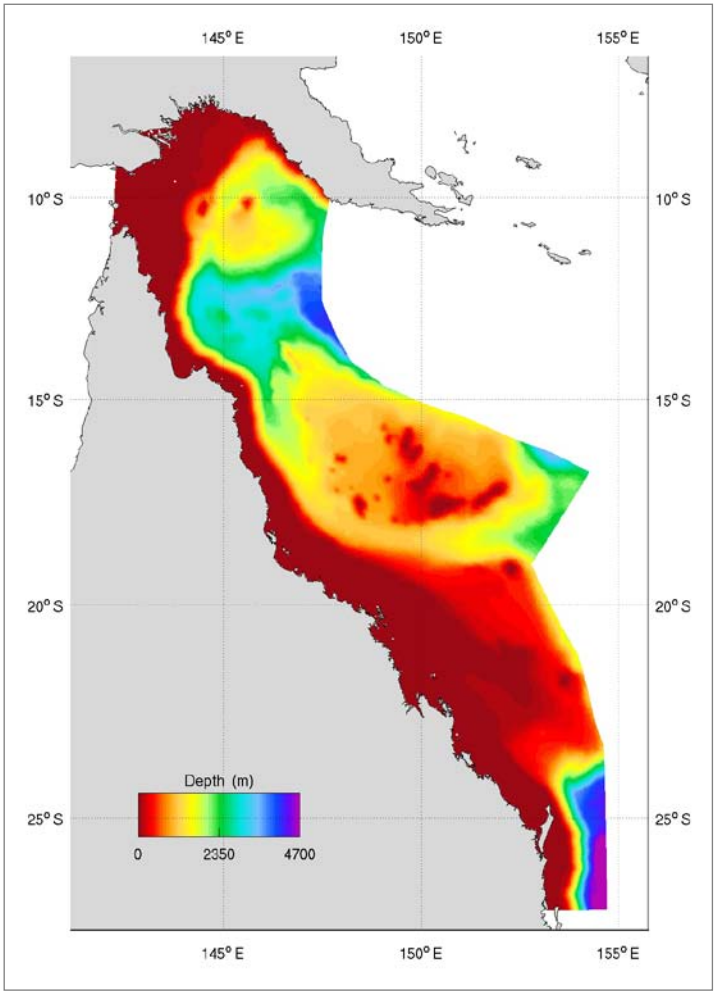


Figure 1: Approximate domain of whole-of-GBR model.

At a spatial resolution of approximately one kilometre, a whole-of-GBR model represents a major step forward in both spatial coverage and resolution, but also presents a significant increase in the complexity of the modeling problem. At the proposed resolution, a computational domain of similar extent to that shown in Figure 1 will have around 700,000 surface elements and a total of approximately nineteen million active computational cells. This size of problem is approaching the size of many global ocean modeling problems (for example, the BlueLink OFAM model has ~1.2 million surface elements). Managing a problem of this complexity and utilizing new supercomputing infrastructure will require the

development of new tools for tasks such as grid preparation, diagnosis of model performance, analysis of model output and optimising the computational efficiency for the chosen computing platform.

Project Outputs / Milestones for 2009/10

Objective	Targeted Activity	Completion Date
1	Installation and testing of hydrodynamic modeling suite at AIMS, including ancillary systems for automated collection and formatting of model input data.	November 2009
1,2	Creation of model grid and preliminary establishment of 4 km model.	December 2009
1,2,3	Pilot implementation of 1 km hydrodynamic model for continental shelf of regions of GBR.	February 2010
2	Hindcast of 2009 wet season at 4 km resolution using all available digital data on river inflow for catchments draining into the GBR.	April 2010
3	Initiation of numerical experiments to assess the suitability of sub-grid parameterisation schemes appropriate for application within finite difference models GBR model.	April 2010
2	Stakeholder and user workshop to facilitate dissemination of project results to date.	May 2010
1,2,3	Report on project progress and work undertaken on all components of the program.	June 2010

Project 2.5i.1 Milestones 2009/10

For 2009/10 outputs only					
Milestones	**Date**	**MTSRF to AIMS**	**MTSRF to CSIRO**	**GBRMPA to AIMS**	**GBRMPA to CSIRO**
Signing of contract		$27,354	$13,478	$16,652	$8,206
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-	-
Report 1 submission: • Report on project progress and work undertaken on all components of the program	31 January 2010	$27,354	$13,480	$16,652	$8,206
Report 2 submission: • Report on project progress and work undertaken on all components of the program	30 June 2010	$27,354	$13,480	$16,652	$8,206
Total MTSRF and GBRMPA Funding		**$82,062**	**$40,438**	**$49,956**	**$24,618**

Project 2.5i.1 Budget

Year 1 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
GBR Receiving Water Modeling	$74,574	-	$74,574
MTSRF	$122,500	-	$122,500
MTSRF Visual Documentation	$2,500	-	$2,500
AIMS	-	$131,888	$131,888
CSIRO	-	$64,935	$64,935
Total	**$199,574**	**$196,823**	**$396,397**

AIMS Project 2.5i.1 Budget 2009/10

Item	MTSRF	GBRMPA	In-kind	Total
Salaries	$31,707	$19,302	$51,009	$102,018
Operating	$6,838	$4,162	$5,000	$16,000
Travel	$5,594	$3,406	-	$9,000
Comm.	-	-	-	-
Capital	$6,216	$3,784	-	$10,000
Institutional overheads	$31,707	$19,302	$75,879	$126,888
Total	**$82,062**	**$49,958**	**$131,888**	**$263,908**

CSIRO Project 2.5i.1 Budget 2009/10

Item	MTSRF	GBRMPA	In-kind	Total
Salaries	$14,944	$9,097	$26,444	$50,485
Operating	$6,061	$3,689	$5,250	$15,000
Travel	$5,628	$3,371	$8,750	$17,749
Comm.	-	-	-	-
Capital	-	-	-	-
Institutional overheads	$13,805	$8,461	$24,491	$46,757
Total	**$40,438**	**$24,618**	**$64,935**	**$129,991**

PROGRAM 5I: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE GREAT BARRIER REEF

Project 2.5i.2: Early warning and assessment system for thermal stress on the Great Barrier Reef

Project Leader and Host Organisation

Professor Ove Hoegh-Guldberg, University of Queensland (UQ)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Dr Ray Berkelmans	AIMS	Coral Ecology	0.25
Dr Sophie Dove	UQ	Coral Physiology	0.2
Prof. Ove Hoegh-Guldberg	UQ	Coral Physiology	0.1
Dr Brad Congdon	JCU	Seabird Ecology	0.1
Mr Craig Steinberg	AIMS	Physical Oceanography	0.25
Dr Madeleine van Oppen	AIMS	Coral and Algal Genetics	0.15
Dr Scarla Weeks	UQ	Satellite Oceanography	0.25
Mr Nikolaus Csaszar	UTS/AIMS	Coral and Algal Genetics	student
Ms Ana Redondo Rodriguez	UQ/AIMS	Oceanography	student

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
DEWHA	Kevin Gale
GRBMPA	Paul Marshall
AMPTO	Col McKenzie / Alan Wallish
WWF	Cassandra Brooke, Martin Taylor

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

(a) Climate change and projections for net annual growth rates

The objective has been expanded from that of “improving our ability to detect coral stress and predict coral mortality risks in the future” to take account of the observation that mortality in clonal organisms is essentially negative growth that can be counteracted by rapid positive growth. The newly stated goal is “to improve our ability to detect coral stress and predict sustained downturns in coral cover resultant from future climate scenarios”. The new aspect of this goal is to develop new models that incorporate knowledge about how key environmental factors affect coral growth, specifically the balance between rates of polyp mortality and fission, in addition to calcification rates. The models will be calibrated using seasonal data and controlled laboratory experiments in which the responses of acroporid corals, from several GBR latitudes, to temperature, CO_2 and water quality will be determined. Experiments will seek to determine physical conditions that led not only to mortality (negative

coral growth), but also to rapid coral growth. Additionally, they will seek to determine the role that variations in carbon translocation from symbiont to host have on host growth rates to improve our understanding of the relationship between bleaching and coral growth. This later feature is added due to the fact that data collected to date suggest that corals can be significantly bleached without necessarily compromising net photosynthesis with remnant symbionts working harder, and based on the observation in Berkelmans and van Oppen (2006) that corals that don't bleach can be equally susceptible to polyp mortality at elevated temperature as corals that do bleach. Resultant predictors for net annual growth rates will be incorporated into projection models of how reefs might change as seas warm (and acidify) (Project 2.5i.1: *Regional climate scenarios* and Project 2.5i.4: *Tools to support resilience-based management in the face of climate change*). An important outcome is the development of an expanded framework for how climate-change stressors impact on coral communities at levels ranging from cell biology to community ecology.

(b) Heritability and genetics

The identity of coral symbionts (*Symbiodinium*) is of importance because physiological differences between *Symbiodinium* types partly determine the response of their host to increased water temperatures and bleaching. Substantial variability in *Symbiodinium* has been revealed in studies by the Hoegh-Guldberg and van Oppen laboratories and collection efforts by LaJeunesse *et al.* (2003, 2004) at a southern and central Great Barrier Reef site. In the first stage of this project, we documented existing information on *Symbiodinium* identity and expanded the collection with targeted sites and host genera. Parts of these collections are being analyzed while some targeted sites still need to be included. Understanding abundance and tolerance ranges across the extent of host species present under a wide range of sites along the GBR, each with distinct environmental conditions, will have significant outcomes for management strategies designed to minimize climate impacts.

(c) Oceanography, bleaching and higher trophic effects

The role of mesoscale oceanographic patterns and variability will be investigated to better understand their link to, and influence on, mass coral bleaching and higher trophic animals, especially sea birds. Modis SST and chlorophyll remote sensing data will be used to explore the GBR oceanography and it influence on biological systems. SST and chlorophyll climatologies have been generated as a one-kilometre resolution baseline essential for future studies, showing distinct "bio-geographic provinces" across the GBR region. The higher resolution time series have provided unique insights into coral bleaching patterns in the southern GBR, particularly for the inshore Keppels Islands reefs. Further to this, we will investigate how broad-scale climate change phenomena translate into changes within the GBR ecosystem and impact reefs on the meso- and smaller-scale. Key environmental variables will be mapped in space and time to improve our understanding 'of climate change impacts across the scale of the GBR ecosystem. The spatial-temporal variability of the physical dynamics will be investigated to determine the biological response, and also whether particular reef systems may be heated or cooled (flushed) and hence likely to experience coral bleaching and mortality or not.

Seabird foraging and reproductive success is explicitly linked to both local and large-scale oceanographic variation. We will investigate the relationships between prey availability/ accessibility and specific physiochemical oceanographic parameters at different scales. These data will be combined with satellite and hydrodynamic information on meso-scale oceanographic variability to better predict how seabirds will respond to projected increases in both SST and other ENSO associated phenomena. Further, we will aim to assess both behavioral and developmental plasticity in multiple seabird species under fluctuating resource availability. These project components will allow determination of the likely range of oceanographic and climatic conditions within which seabird reproduction on the GBR will remain viable.

Project Outputs/Outcomes

(a) Improvement in our ability to detect coral stress and predict coral mortality risks in the future

- Bleaching thresholds developed after the 1998 bleaching event have been reviewed and refined. A number of reefs in the central GBR appear to have increased their threshold since the 2002 bleaching event.
- We have refined our understanding of the drivers that lead to mass coral bleaching events: Bleaching has been linked to upwelling events and to seasonal anomalies in temperature.
- We have demonstrated that bleaching does not necessarily lead to reduced production (photosynthetic rates) by endosymbiotic dinoflagelles as remnant symbionts tend to work harder. This perhaps is allied to the corals ability to alleviate light stress through morphological plasticity.
- We have demonstrated that mortality following bleaching events is alleviated by heterotrophy, and compounded by the length of the bleaching event. However, on reefs dominated by acroporids, significant mortality can be recovered in an annual cycle by the regeneration of tissue from surviving polyps over pre-existing skeletons.
- These results have resulted in the new goal of understanding how climate change will influence net annual growth in corals with the aim of including both the effects of ocean acidification and non-summer growth potential into the evaluation of how corals will fare in the future (as presented at the 3rd MTSRF Conference, April 2009).

(b) Heritability and genetics

- The potential for genetic adaptation was quantified for two GBR populations of the coral *Acropora millepora* for seven thermal tolerance traits. Traits associated with zooxanthellae show high potential for adaptation in some circumstances. However, the adaptation potential of the host coral itself is mixed with high potential for growth adaptation and low potential for traits associated with major stress and antioxidant genes.
- A database of *Symbiodinium* identity (if available subclade was included) has been established incorporating data from articles up to 2009. The database is comprised of 3400 entries that cover 62 collection sites situated in the Cairns (8 sites), Central (41 sites) and Capricorn Section (13 sites) of the GBR. Sections were further subdivided into in-shore, mid-shelf and outer reefs.

(c) Oceanography, bleaching and higher trophic effects

- An improved method using satellite SST that takes into account seasonal pre-warming trends has been developed for predicting coral bleaching. Unlike other satellite-based early-warning tools, this method successfully hindcast the 2006 bleaching event in the southern GBR.
- Daily acquisition processing and product generation of 1 km MODIS SST, chlorophyll and light attenuation data to allow monitoring of these environmental parameters at highest temporal and spatial resolution across the scale of the GBR ecosystem.
- Development of MODIS SST and chlorophyll climatologies for the greater GBR and Coral Sea regional waters, and northern and southern GBR regions to determine long-term trends and generation of spatial and temporal anomalies in these regions.
- Acquisition and analysis of in situ oceanographic and meteorological measurements for validation of satellite imagery and to provide detailed structure through the water column.

- Regular update of relevant variables and indices during the summer as they relate to bleaching to GBRMPA, and other relevant institutes.
- Web delivery of current temperature trends against long-term means as well as current time-temperature trends against (updated) bleaching thresholds.
- Link established between upwelling activity and hot summers on the GBR. Unusual upwelling activity can be used as a seasonal forecasting tool with a lead time of one to two months. Large upwelling events coincide with major intrusion of Coral Sea water onto the central GBR shelf which is visible in MODIS imagery. Upwelling activity is enhanced when the East Australian Current (EAC) is flowing strongly.
- Seabird foraging and reproductive success has been linked to both local and large-scale oceanographic variation showing seabirds of the GBR to be sensitive upper-trophic-level indicators of potential climate change impacts at a range of spatial scales.

Project Activities for 2009/10

Objective	Targeted Activity	Completion Date
(a)	• An investigation of seasonal variation in coral growth rates for acroporids to better understand environmental conditions that lead to optimal growth rates in corals. • An investigation of the effect of varying temperature and pCO_2 on carbon acquisition by symbionts, carbon translocation to hosts, and resultant host growth rates (inclusive of mortality) to better understand how changing symbiont densities under different climate scenarios relate to the acquisition of organic carbon by coral hosts; together with an understanding of how this carbon is allocated between the maintenance of existing polyps and the production of new polyps. • An investigation of the cellular fate of inorganic nitrogen taken up by reef-building corals to determine whether increasing the concentration of dissolved organic carbon affects the fate of inorganic nitrogen in the symbiosIsland	June 2010
(b)	• Provide a summary of the results obtained on the adaptive potential of the coral *Acropora millepora* and its zooxanthellae to climate warming and place these results in a broader context and map out future research into the genetic adaptation of corals. • An investigation of *Symbiodinium* diversity comparing inshore and offshore locations, and between latitudinally distinct locations to identify areas of the GBR that might be more resilient to anomalous increases in sea temperature.	June 2010
(c)	• An investigation of the link between oceanographic processes, including upwelling, EAC dynamics, productivity and coral bleaching to develop a seasonal predictor of bleaching and assess their importance to ecological processes. • An investigation of the relationships between specific physio-biological oceanographic parameters and seabird prey availability/ accessibility, at different scales to better predict how seabirds will respond to projected increases in both SST and other ENSO associated phenomena.	June 2010

Project 2.5i.2 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF Payments		
Milestones		**UQ**	**AIMS**	**Total**
Signing of contract		$47,500	$19,000	$66,500
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-
Report 1 submission: *Climate change and projections for net annual growth rates:* • Final report (with appropriate attribution of MTSRF funding) describing the results of complete analysis of carbon acquisition and fate for seasonally collected samples from Heron and Lizard Island. • Final report (with appropriate attribution of MTSRF funding) describing the results of complete analysis of fate of inorganic nitrogen samples. • Preliminary report (with appropriate attribution of MTSRF funding) describing the results of initial analysis of growth data, and of experimental response of carbon flow to climate scenarios. *Responsible Personnel: Dove, UQ* *Heritability milestones:* • PhD thesis of Nikolaus Csaszar submitted (with appropriate attribution of MTSRF funding). Thesis abstract delivered to RRRC *Responsible Personnel: M. van Oppen / Csaszar, AIMS* *Genetics milestones:* • Collect *Symbiodinium* samples from the Far Northern GBR. • Complete laboratory analysis of samples collected from inshore sites (Mackay/Lizard). Submit manuscript (with appropriate attribution of MTSRF funding and a copy submitted to RRRC) on *Symbiodinium* literature based database. *Responsible Personnel: Tonk, UQ* *Oceanography, bleaching and higher tropic effects milestones:* • Evidence of provision of MODIS SST and Ocean Colour data and interpretation to GBRMPA and the e-Atlas on bleaching conditions during summer. *Responsible Personnel: Weeks, UQ.* • Evidence of ongoing provision of MODIS satellite data from NASA to UQ. *Responsible Personnel: Weeks, UQ.*	31 January 2010	$45,000	$20,000	$65,000

For 2009/10 outputs only	Date	MTSRF Payments		
Milestones		**UQ**	**AIMS**	**Total**
• Provision of update reports on current conditions, indices and seasonal outlooks as they relate to coral bleaching to the e-Atlas. *Responsible Personnel: Redondo-Rodriguez / Weeks, UQ; Berkelmans / Steinberg, AIMS* • Process and database full long-term EAC current data from Myrmidon and Jewel Reefs. *Responsible Personnel: Steinberg, AIMS* • Preliminary analysis of the influence of local meteorological variation on adult foraging success and potential links to local oceanographic variation. *Responsible Personnel: Congdon, JCU;, Weeks, UQ.*				
Report 2 submission: *Climate change and projections for net annual growth rates:* • Final report describing the results of complete analysis of seasonal growth data from Lizard and Heron Island. • Final report on a model for predicting net annual growth rates under climate change scenarios *Responsible Personnel: Dove, UQ* *Heritability milestones:* • Final report on the adaptive potential of the coral *Acropora millepora* and its zooxanthellae to climate warming *Responsible: van Oppen, AIMS* *Genetics milestones:* • Complete laboratory analysis and report results of samples collected from Far Northern GBR sites. Submit manuscript on Lizard *Symbiodinium* samples (with appropriate attribution of MTSRF funding and a copy submitted to RRRC). *Responsible: Tonk, UQ.* *Oceanography, bleaching and higher tropic effects milestones:* • Final report on the long-term trends in EAC dynamics and climate signals. *Responsible: Steinberg, AIMS* • Submit manuscript describing the link between upwelling and bleaching (with appropriate attribution of MTSRF funding and a copy submitted to RRRC). *Responsible: Berkelmans, AIMS.*	10 June 2010	$45,000	$20,000	$65,000

For 2009/10 outputs only	Date	MTSRF Payments		
Milestones		**UQ**	**AIMS**	**Total**
• Final report (with appropriate attribution of MTSRF funding describing) further overlays of satellite telemetry foraging data on meso-scale oceanographic information to confirm and/or extend the number of critical 'at-distance' foraging locations and the associated oceanographic features. *Responsible: Congdon, JCU / Weeks, UQ* • Final report (with appropriate attribution of MTSRF funding) on oceanographic phenomena used by local foraging shearwaters in the southern GBR during chick rearing based on multiple seasons data. *Responsible: Congdon, JCU / Weeks, UQ / Steinberg, AIMS.* • Final report (with appropriate attribution of MTSRF funding) on oceanographic phenomena used by local foraging boobies/tropicbirds in the northern GBR during chick rearing. *Responsible: Congdon, JCU / Weeks, UQ* • Meta-data describing all data generated by MTSRF Project 2.5i.2 lodged on the e-Atlas				
Total MTSRF Funding		**$137,500**	**$59,000**	**$196,500***

* Totals exclude $3,500 MTSRF funding for Visual Documentation Allocation.

Project Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$196,500	-	$196,500
MTSRF Visual Documentation*	$3,500	-	$3,500
The University of Queensland	-	$200,000	$200,000
Australian Institute of Marine Science	-	$242,000	$242,000
Total	**$200,000**	**$442,000**	**$642,000**

* A total of $3,500 held by RRRC for Visual Documentation for this project (see Theme 5).

UQ Project 2.5i.2 Budget 2009/10

Item	MTSRF Funds	UQ In-kind	Total Cost
Salaries	$90,000	$74,000	$164,000
Operating	$30,000	$30,000	$60,000
Travel	$7,000	$7,000	$14,000
Communication / Extension	$10,500	$20,000	$30,500
Satellite data	-	$50,000	$50,000
Capital	-	-	-
Institutional overheads	-	$19,000	$19,000
Total	**$137,500**	**$200,000**	**$337,500**

AIMS Project 2.5i.2 Budget 2009/10

Item	MTSRF Funds	AIMS In-kind	Total Cost
Salaries	$49,000	$25,000	$74,000
Operating	$10,000	$120,000	$130,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$97,000	$97,000
Total	**$59,000**	**$242,000**	**$301,000**

PROGRAM 5I: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE GREAT BARRIER REEF

Project 2.5i.3: Resilience to climate change

Project Leaders and Host Organisations

Professor Terry Hughes, James Cook University (JCU)
Dr Julian Caley, Australian Institute of Marine Science (AIMS)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Professor Bette Willis	JCU	Coral Biology and Ecology	0.15
Dr Madeleine van Oppen	AIMS	Coral and Algal Genetics	0.15
Dr Julian Caley	AIMS	Evolutionary Biology	0.1
Dr Line Bay	JCU	Coral Genetics	0.05
Professor Terry Hughes	JCU	Coral Ecology	0.1
Professor David Bellwood	JCU	Fish Biology and Ecology	0.1
Dr Morgan Pratchett	JCU	Fish Biology and Ecology	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Laurence McCook / Roger Beeden
AMPTO	Col McKenzie / Alan Wallish
WWF	Cassandra Brooke, Martin Taylor

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

The project will examine the resilience of coral and reef fish assemblages to climate change and investigate how impacts of climate change will interact with other human induced stresses to influence the resilience of coral reef ecosystems. The project will utilise existing strengths in the population genetics and genomics of corals and their algal endosymbionts, in the population, community and ecosystem ecology of corals and reef fishes, and in mechanistic modelling. A key outcome will be an integrated, multi-level, assessment of climate change effects on GBR corals and fishes. Key components of the life history, community ecology and functional capacity of corals and reef fishes will be targeted to determine how individuals, populations and communities will respond to climate change, and to assess the feedback that these impacts will have on the resilience of coral reef ecosystems within the GBRMP.

Key Objectives:

Resilience of coral assemblages to climate change

(a) Estimate genetic connectivity among GBR populations of coral and their algal endosymbionts to determine their potential for replenishment following disturbances associated with climate change.

(b) Identify mechanisms of acclimatisation and adaptation available to local coral populations to understand their potential for adaptation to climate change.

(c) Identify links between thermal anomalies and coral disease dynamics to predict the response of coral assemblages to ocean warming associated with climate change.

Resilience of fish assemblages to climate change

(d) Quantify current levels of herbivory by reef fishes on the GBR and evaluate the extent to which reefs across the GBR shelf are vulnerable to ecosystem phase-shifts and domination by macroalgae as a result of climate change.

(e) Identify critical thresholds in macro-algal phase shifts and evaluate alternate management strategies in order to limit the impacts of climate change on the ability of fish assemblages to prevent ecosystem phase-shifts on coral reefs.

(f) Evaluate the long term recovery and resilience of reef fish communities to climate change induced habitat degradation.

Project / Task Methodology

Objective (a): Estimate genetic connectivity among GBR populations of coral and their algal endosymbionts to determine their potential for replenishment following disturbances associated with climate change

Connectivity within and between coral populations is an important component of coral reef resilience. Exchange of larvae creates and maintains high levels of genetic diversity and buffers populations against disturbance. Migrants may carry new alleles that may be integrated into populations through reproduction, creating new gene combinations on which selection can potentially act. The spread of selectively advantageous alleles at DNA loci involved in physiological responses such as bleaching resistance is a potentially important consequence of migration. Furthermore, gene flow increases local effective population sizes, thereby enhancing the ability of populations to resist rapid random changes in allele frequencies from one generation to the next through drift. Larval-exporting or source reefs with diverse populations of healthy adult corals are essential to maintain the genetic diversity and resilience of larval-importing or sink reefs. Therefore, an assessment of larval transport in and out of reefs, i.e. the extent to which reefs are self-seeding or accumulate recruits from surrounding areas, as well as the direction of larval dispersal will improve our ability to forecast how reef corals are likely to respond to environmental change. Successful migrants leave a genetic signature of their movements and allow inference of connectivity using population genetic methods. We will estimate genetic connectivity among GBR populations of coral and their algal endosymbionts using analysis of DNA microsatellite loci, and link this information to hydrodynamic models to provide improved estimates of reef connectivity.

Objective (b): Identify mechanisms of acclimatisation and adaptation available to local coral populations to understand their potential for adaptation to climate change

Observed differences in bleaching sensitivity between geographically distinct, conspecific coral populations may be caused by differential expression of genes involved in the bleaching response. Differential gene expression may occur as a consequence of either local adaptation or acclimatisation, and/or by the presence of distinct alleles at these loci (due to

selection and local adaptation). Microarray and quantitative real time PCR analyses will be used to examine gene expression differences between geographically distinct coral populations. Common garden and reciprocal transplant experiments will be used to assess the relative importance of local environmental variation (acclimatisation) and genetic differentiation (adaptation) in producing gene expression variation. This will allow for an assessment of the environmental and genetic drivers of observable phenotypic variation in bleaching resistance and whether these processes vary among geographically distinct coral populations.

Theoretical models of the potential for corals to evolve greater bleaching resistance in response to climate change will be developed as part of this objective. Results from the empirical studies described above will be used to parameterise these models and model outputs will be used in turn to guide the design of further experiments.

Objective (c): Identify links between thermal anomalies and coral disease dynamics to predict the response of coral assemblages to ocean warming associated with climate change

Increases in the severity and frequency of wildlife disease epidemics over the past three decades are thought to be linked, in part, to increasing thermal stress associated with climate change. Understanding the implications of increasing ocean temperatures for the spread of coral pathogens and for disease resistance of corals will significantly enhance current understanding of the resilience of GBR coral assemblages in relation to climate change. We will determine the linkages between seasonal thermal anomalies and the prevalence of coral disease. A modelling approach will be used to evaluate metrics of thermal anomalies based on NOAA satellite data that best explain spatial and temporal patterns in the prevalence of coral disease on the GBR. The relationship between peaks in disease prevalence and thermal anomalies will be analysed to determine thermal thresholds associated with outbreaks of coral disease. We will also identify interactions between bleaching and disease. We aim to produce algorithms to (a) relate temperature to past disease outbreaks, and (b) develop a product that provides predictive outlooks for outbreaks of key coral diseases, similar to the NOAA hotspot algorithm that predicts bleaching events.

Objective (d): Quantify current levels of herbivory by reef fishes on the GBR and evaluate the extent to which reefs across the GBR shelf are vulnerable to ecosystem phase-shifts and domination by macroalgae as a result of climate change.

Objective (e): Identify critical thresholds in macro-algal phase shifts and evaluate alternate management strategies in order to limit the impacts of climate change on the ability of fish assemblages to prevent ecosystem phase-shifts on coral reefs

Climate change will influence the community structure of reef fish assemblages, however, it is unknown if these changes will affect ecosystem processes, and subsequently lead to a phase shift from coral to algal dominated reefs. Here, we will utilise and build on existing databases of the distribution and abundance of herbivorous fishes across the GBR to quantify current rates of herbivory. These data will be combined with direct experimental analyses of fish-algal interactions that will enable us to estimate the current capacity of GBR reef fish populations to maintain low macroalgal cover on mid and outer reefs. The second part of this objective will use a modeling approach to permit direct estimation of critical thresholds in the coral – macroalgal phase shift and to evaluate alternative management strategies to respond to changes in macro-algal distributions. We will combine the results from part one with existing algal distribution data and algal growth trajectories to model fish-algal interactions and outcomes under a range of climate change scenarios. Furthermore, it will provide us with an indication of the relative resilience of different components of the GBR ecosystem. In particular, it will indicate to what extent the current stands of macroalgae on inshore reefs reflect a state of heightened vulnerability to climate change.

Objective (f): Evaluate the long term recovery and resilience of reef fish communities to climate change induced habitat degradation

The most immediate and substantial effects of climate change on coral reefs are severe episodes of climate-induced coral bleaching, which cause widespread mortality of reef corals. Extensive mortality of reef corals results in the loss of essential habitat for coral reef fishes, leading to reduced abundance and localised extinction of coral reef fishes. While many studies have documented sudden declines in the abundance of fishes immediately following extensive coral depletion, the degree to which fish communities are resilient and may eventually recover is currently unknown.

We will conduct a detailed analysis of the recovery and resilience of fish assemblages at Trunk Reef, central GBR, which were severely impacted by climate induced coral bleaching in 2001/02. Recovery of reef fish assemblages is likely to be contingent upon increases in coral cover and a return to pre-disturbance structure of benthic communities. Changes in the structure and dynamics of fish communities will be monitored annually and directly compared to temporal changes in the physical and biological structure of benthic habitats.

Project Outputs / Outcomes

Objective (a): Estimate genetic connectivity among GBR populations of coral and their algal endosymbionts to determine their potential for replenishment following disturbances associated with climate change.

A paper has been published in the journal Coral Reefs, presenting genetic analyses of Great Barrier Reef (GBR) populations of clade C *Symbiodinium* hosted by the alcyonacean coral, *Sinularia flexibilIsland* Allelic variation at four newly developed microsatellite loci demonstrated that *Symbiodinium* populations are genetically differentiated at all spatial scales from 16 to 1,360 km; the only exception being two neighbouring populations in the Cairns region separated by 17 km. This indicates that gene flow is restricted for *Symbiodinium* C hosted by *S. flexibilis* on the GBR. Patterns of population structure reflect longshore circulation patterns and limited cross-shelf mixing, suggesting that passive transport by currents is the primary mechanism of dispersal in *Symbiodinium* types that are acquired horizontally. There was no correlation between the genetic structure of *Symbiodinium* populations and their host *S. flexibilis*, most likely because different factors affect the dispersal and recruitment of each partner in the symbiosIsland The genetic diversity of these *Symbiodinium* reef populations is on average 1.5 times lower on inshore reefs than on offshore reefs. Lower inshore diversity may reflect the impact of recent bleaching events on *Sinularia* assemblages, which have been more widespread and severe on inshore reefs, but may also have been shaped by historical sea level fluctuations or recent migration patterns.

Specific primers have been developed for population-level markers targeting additional strains of *Symbiodinium* commonly hosted by corals on the GBR. This will be reported on in detail in the June 2009 report.

A manuscript has been submitted in May 2009 (journal Conservation Genetics) on spatial and temporal patterns in population genetic structure for four scleractinian coral species of the *Acropora aspera* group, *A. millepora*, *A. papillare*, *A. pulchra* and *A. spathulata*, at three locations within the Palm Islands in the central Great Barrier Reef. Species boundaries and spatial genetic structure were evaluated from samples of all four species collected in 2004, six years after the mass bleaching event of 1998. *A. millepora* and *A. pulchra* were also sampled in 1997, enabling a temporal comparison across a major disturbance event. All pairwise comparisons between species showed significant genetic differentiation, supporting species delineations. Conspecific populations examined from Orpheus and Pelorus Island (separated by ~1 km) were panmictic in both 1997 and 2004, but the Fantome Island

populations were genetically distinct, despite being located only 11 km away. A change in the genetic composition, measured as significant pairwise F_{ST} of *A. millepora* and *A. pulchra* populations was observed between the 1997 and 2004 samples. Even though the 1998 coral bleaching event caused extensive mortality, only marginal changes in levels of genetic diversity were detected between 1997 and 2004 population samples and neither species displayed evidence of a recent genetic bottleneck in 2004. These results suggest that recovery has mainly occurred through re-growth of cryptic patches of remnant tissue. *A. papillare* exhibited significantly lower genetic diversity compared to the other three species, consistent with its rare occurrence in the Palm Islands and throughout its distributional range, and was the only species to display evidence of a genetic bottleneck in 2004.

Objective (b): Identify mechanisms of adaptation available to local coral populations to understand their potential for adaptation to climate change

Microarray analyses have examined gene expression variation between inshore and offshore populations of the scleractinian coral, *Acropora millepora,* in the wild and in a common laboratory environment. This work has recently been accepted in Molecular Ecology (IF = 5.1).

We investigated variation in transcript abundance of *A. millepora* within and between populations characteristically exposed to different turbidity regimes and hence different levels of light and suspended particulate matter. We examined phenotypic plasticity by comparing levels of gene expression between source populations and following ten days of acclimatisation to a laboratory environment. Analyses of variance revealed that 0.05% of genes were differentially expressed between source populations, 1.32% following translocation into a common laboratory and 0.07% in the interaction (source population-dependent responses to translocation). Functional analyses identified an over-representation of differentially expressed genes associated with metabolism and fluorescence categories (primarily down-regulated), and environmental information processing (primarily up-regulated) following translocation to a lower light and turbidity environment. Such metabolic down-regulation may indicate non-oxidative stress, hibernation or caloric restriction associated with the changed environmental conditions. Green fluorescent protein-related genes (GFPs) were the most differentially expressed and were exclusively down-regulated; however, GFP protein levels remained unchanged following translocation. Photophysiological responses of corals from both locations were characterised by a decline when introduced to the common laboratory environment but remained healthy (Fv/Fm > 0.6). Declines in total lipid content following translocation were greatest for inshore corals, suggesting that turbid water corals have a strong reliance on heterotrophic feeding.

The clonal organization of corals offers unique opportunities to investigate phenotypic differentiation as a result of biological processes (eg. growth and reproduction) and /or small scale environmental variation (e.g. as a consequence of water movement and light availability) between parts of colonies. To examine the potential for variation in gene expression between the centre, periphery, top and base of colonies we sampled three colonies from one location for microarray analysIsland Preliminary analysis indicates that the majority of variation in gene expression was between colonies (Figure 1). Variation within colonies was also detected in metabolic and fluorescent protein genes between the top, base, periphery and centre. We will report on these findings in detail in the June 2010 report.

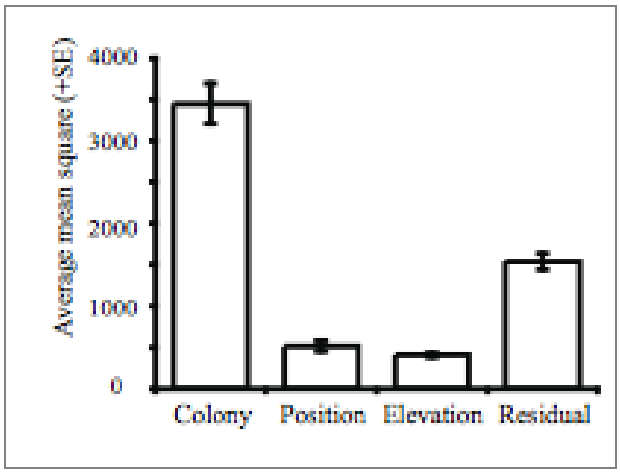


Figure 1: Relative importance of colony, position (periphery or centre) and elevation (top or base) in determining gene expression variation in *Acropora millepora*.

Microarray analyses have identified a large amount of technical variation. To reduce such technical variation we have developed a new microarray using the Agilent platform. Because this platform contains probes of equal length and replication per gene this array offers a more accurate and sensitive assessment of gene expression variation. We are currently testing this array and will report on this milestone on 1 March 2010.

We have developed multiplex real time assays to examine expression differences in genes associated with oxidative stress and coral bleaching. We have already reported on the progress in the March 2009 report and will further report on our findings on 1 March 2010.

Reciprocal transplantation experiments in corals offer an excellent opportunity to examine the potential for gene expression variation between geographically distinct locations and to partition environmental and genetic drivers of such variation. We have so far undertaken two transplantation experiments (between Magnetic and Keppel Islands in 2008 and between Orpheus and Keppel Islands in 2009). We will report on gene expression analyses of these experiments in the 15 June 2010 final report.

Objective (c): Identify links between thermal anomalies and coral disease dynamics to predict the response of coral assemblages to ocean warming associated with climate change

The addition of a new member to the team, Jeffrey Maynard from the University of Melbourne, this past year has facilitated the development of an improved model to predict outbreaks of white syndrome (WS), the coral disease having one of the highest abundances observed on the GBR. We are currently in the process of developing a predictive tool based on the model that will spatially display the presence of current temperature regimes similar to those that caused white syndrome outbreaks in late 2002. Predictive tools will result in targeted, and hence cost-effective, monitoring of the onset and outbreak of WS at sites where temperature regimes suggest outbreaks are likely to occur. The project has met all milestones set at the project's inception and is now set to go several steps further through the release of predictive tools that we will endeavour to make publicly available before the end of June. The capacity to predict where WS outbreaks are likely to *have* occurred, as well as where they are likely *to* occur, will enable us to answer research questions that have been difficult to impossible to address using available datasets. These include:

1. Is WS transmission density-dependent?
2. What percentage of WS cases result in mortality?
3. Does the percentage of WS cases that result in mortality vary spatially?
4. Does susceptibility to WS, whatever the cause, vary spatially and what contributes to this variability?

Importantly, the predictive tool will shed light on management questions, like:

1. Can susceptibility to and recovery from WS be influenced by actions that managers can take?
2. Can WS outbreak risk be reliably modeled and displayed spatially based on proxy indicators of host cover and climate change-based projections of summer temperatures?

Given the applicability of the results of this project to management, the Great Barrier Reef Marine Park Authority has now become a key partner in this project. The Climate Change Group from the GBRMPA is co-funding production of web-based predictive tools for coral diseases over the coming months. Accordingly, a predictive tool based on the model will be developed in close collaboration with the managers likely to find it most useful including, but not limited to, staff from the Great Barrier Reef Marine Park Authority and the Department of Environment, Water Resources, Heritage and the Arts. Images will be produced that display, in red, locations where heating rates have exceeded the values known to cause the outbreaks in white syndrome observed in 2002. These images, effectively maps of northern Australia, will have reef and island overlays that facilitate their interpretation and will be made viewable over the web as well as through the Google™ Earth platform. An image will be produced for each summer since the 2002 outbreak and all images as well as the Google™ Earth interface will be made available from the CSIRO Marine and Atmospheric Research homepage. Specialists in remote sensing from CSIRO will be collaborating on the project and will be helping to maintain the predictive tool and all supporting documentation over the coming years.

It is expected that at least two papers will be published in high-impact international journals on research relating to links between thermal stress and white syndromes, summarised briefly above. The first, *Predicting white syndrome outbreaks in northern Australia: targeted monitoring and informed management* will be submitted to *Global Change Biology* as soon as the predictive tool has been completed and just prior to its public release in the coming months. The second involves determining whether there are similarities in temperature regimes between sites on the GBR where white syndrome outbreaks occurred and sites in the greater Pacific where there have been similar outbreaks reported. This exercise will help our team determine whether there is scope to use the model described here to develop a predictive tool for white syndrome in the Pacific and potentially globally.

We also proposed to explore links between water quality and disease prevalence, particularly the capacity of remotely sensed measures of water quality to predict spatial patterns in the prevalence and abundance of disease on the inshore Great Barrier Reef. Numerous water quality monitoring programs are in place to improve our understanding of the ways in which inshore reefs are affected by poor water quality resulting from various land-based practices like agriculture and coastal development, but the spatial scales are vast and the monitoring too infrequent. Like temperature though, water quality is measured daily at 1km resolution by polar orbiting satellites. Water quality variables, like chlorophyll content and salinity, are calculated from ocean colour data that is freely available from the SeaWIFS and MODIS satellite platforms. We propose to explore whether new algorithms to process ocean colour data produce water quality data that is correlated to observed patterns in disease abundance and prevalence on the inshore reefs of the GBR. The best algorithms to derive water quality

data from ocean colour data in the coastal systems of Australia have been developed by a team at CSIRO Land and Water lead by Dr. Arnold Dekker, who is providing access to their water quality data. If relationships are found, it is likely that we will be able to produce a series of tools that will help us to understand the links between water quality and some diseases, black band disease in particular. Also, and importantly, it is likely that the tools we may be able to produce would be critical to predicting patterns in the abundance and prevalence of coral diseases following floods. Floods occur often in NE Australia and are expected to become more frequent and severe as a result of climate change.

Objective (d): Quantify current levels of herbivory by reef fishes on the GBR and evaluate the extent to which reefs across the GBR shelf are vulnerable to ecosystem phase-shifts and domination by macroalgae as a result of climate change

One of the greatest challenges facing coral reefs is the threat of phase-shifts, particularly an increase in macroalgae. Key to our understanding of reef resilience and the susceptibility of reefs to phase shifts is an understanding of the role of herbivores. Recent research using underwater video cameras revealed the limitations of traditional methods of visual censuses for understanding the removal of adult macroalgae by fishes. We therefore undertook a series of dedicated trips to trial a new standardized macroalgal bioassay that would permit spatial variation in the extent and nature of herbivory on macroalgae to be evaluated. The trials were highly successful, with up to seventy percent removal of algae in the three-hour period. This method has not been applied at a range of spatial scales from within reefs to a regional comparison spanning from the Low Isles to the Keppel Islands, a transect that encompasses a large proportion of the GBR.

A full scale regional sampling programme has just been completed with over two hundred experimental assays deployed at the Low Islands, the Whitsunday and the Keppel Islands; all completed within a six-week period (to minimise seasonal effects). Initial results point strongly to a highly restricted suite of fishes capable of removing macroalgae. These species appear to play a similar role on inshore reefs along the length of the Great Barrier Reef. The emergent pattern appears to be supporting earlier findings of high local heterogeneity in algal removal rates with just one or two species filling the role in a given location. Removal rates are characterized by high among-site and among-location variation. The capacity of inshore reefs to respond to an increase in macroalgae is likely to be spatially highly variable. It appears to depend, at all scales, on the behaviour and densities of a few key fish species. The primary goal now is to identify potential thresholds and a range of appropriate management options.

To date this work has resulted in a review of herbivory on the GBR (MTSRF internal report), while results have been presented at the Cairns MTSRF meeting, at the 11th ICRS in Florida and at several meetings in Townsville. Two publications have arisen from this work to-date: a conference paper (Cvitanovic *et al.* 2009: MTSRF Annual Conference Proceedings, in press) and one in an international journal *Coral Reefs* (Cvitanovic and Bellwood 2009[9]). Two more publications are in preparation. In terms of outcomes, this work, and meetings with end users, has laid the foundations for further development of coral reef management in order to ensure protection of critical functional groups. Herbivorous fishes have been identified as a key ecological feature in the East Marine Region and are likely to be considered a priority for protection when planning conservation policies.

Objective (e): Identify critical thresholds in macro-algal phase shifts and evaluate alternate management strategies in order to limit the impacts of climate change on the ability of fish assemblages to prevent ecosystem phase-shifts on coral reefs

[9] Cvitanovic, C. and Bellwood, D. R. (2009) Local variation in herbivore feeding activity on an inshore reef of the Great Barrier Reef. *Coral Reefs* 28: 127-133.

Linked to objective (d), this objective has been developed in the last year and will become the major focus in the final year. Modeling has yet to begin, but preliminary data have highlighted the problems associated with traditional approaches. Most approaches assume that visual censuses can give an indication of herbivore activity. Unfortunately, visual counts do not equate to fish presence and presence does not reflect removal rates. There is marked regional variation in ecosystem processes. There are multiple thresholds based on herbivore presence and realised effect.

Objective (f): Evaluate the long term recovery and resilience of reef fish communities to climate change induced habitat degradation

Habitat degradation associated with climate-induced coral bleaching has a significant effect on reef-associated organisms, such as coral reef fishes. Extensive coral loss has immediate and pronounced negative effects on fishes that live, feed or recruit on live corals. Structural collapse of dead coral colonies and reductions in overall habitat complexity will also have far reaching effects on species that associate with coral reefs, leading to marked declines in biodiversity and productivity. While many studies have documented declines in the abundance of fishes immediately following extensive coral depletion, the degree to which fish communities are resilient and may eventually recover is currently unknown.

Ongoing monitoring of fishes and corals in the central GBR (Trunk, rib and Bramble Reef) is important for assessing recovery and resilience in the aftermath of significant coral bleaching and associated habitat degradation in 2001/02. To date (up until January 2009), there has been marked increases in coral cover at some sites (but not others). However, the coral community is very different from the pre-disturbance community and so it remains to be seen if and when reassembly of coral communities will begin. Similarly, there has been little apparent recovery of fish assemblages. Research for the remaining period of this project will focus on trying to assess key limitations to recovery of both fish and coral assemblages.

Project Targeted Activities 2009/10

Objective	Targeted Activity	Completion Date
(a)	Genotyping of *Symbiodinium* C2 within *Acropora millepora* coral populations on the Great Barrier Reef using developed *Symbiodinium* microsatellites. Data will be used to infer the spatial connectivity of populations on reefs within and between the Central and Southern regions of the GBR	1 Mar 2010
(a)	Development of new microsatellite markers for *Seriatopora hystrix* on the GBR for parentage analysis in low diversity populations	1 Mar 2010
(a)	Examination of small-scale population genetic structure of Lizard Island and Palm Island *S. hystrix* populations, a comparison of habitats (*i.e.* exposed vs. sheltered) and regions	1 June 2010
(a)	Genotyping of *Symbiodinium* C2 within healthy and stressed (=bleached) colonies of *Acropora millepora* from different reefs using developed *Symbiodinium* microsatellites. Data will be used to assess temporal variation in the genetic composition of *Symbiodinium* assemblages hosted by corals and how genetic variation is impacted by coral bleaching.	1 June 2010
(b)	Development of high through-put multiplex oxidative stress gene expression method in corals	1 Mar 2010
(b)	Development of new generation microarray technology for high through-put gene expression screening in corals	1 Mar 2010
(b)	Examination of the clonal sources of gene expression variation in corals	1 June 2010
(c)	Completion of coral disease prevalence surveys at key sites that experienced thermal stress, consistent with model predictions of likely white syndrome outbreaks, during summer 2008/09.	1 Mar 2010
(c)	Testing of the disease-temperature model at GBR and other Indo-Pacific locations for which data are available to predict the likelihood of white syndrome outbreaks in response to SST anomalies.	1 Mar 2010
(c)	Examination of the capacity of remotely sensed measures of water quality to predict spatial patterns in the prevalence and abundance of diseases like black band disease on the inshore Great Barrier Reef.	1 June 2010
(c)	Examination of the vulnerability of GBR corals to disease in relation to ocean warming.	1 June 2010
(d), (e)	Delivery of an initial report on regional scale variation in inshore reef susceptibility to coral-algal phase-shifts and ecosystem collapse; including an initial evaluation of herbivore abundances and ecosystem thresholds.	1 March 2010

Objective	Targeted Activity	Completion Date
(d), (e)	Completion of field and experimental evaluation of algal ecosystem thresholds, modeling of coral algal phase shifts under different climate change scenarios.	1 June 2010
(d), (e)	Delivery of final report on vulnerability of GBR to climate change induced shifts in macroalgae distribution and abundance in relation to fish herbivory and present options for alternate management options.	1 June 2010
(f)	Completion of2009/10 surveys of fish and coral assemblages; sampling design extended to include Trunk Reef, Rib Reef and Bramble Reef.	1 March 2010
(f)	Identification of appropriate scales and likely sources of larval supply, especially among reef fishes	1 June 2010
(f)	Explore the relative importance of pre- versus post-settlement processes in limiting recovery and resilience of coral reef communities	1 June 2010
all	Final end-user briefings, seminars or workshops to communicate results and contribute to management strategies. Publish and disseminate peer-reviewed scientific publications	June 2010

Project 2.5i.3 Milestone Payments 2009/10

For 2009/10 outputs only		Payments		
		JCU		AIMS
Milestones	**Date**	**MTSRF**	**RRRC**	**MTSRF**
Signing of contract		$50,000	$15,000	$30,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-
Report 1 submission: • Progress report on activities conducted to achieve objectives (above) including: o Genotyping of *Symbiodinium* C2 within *Acropora millepora* coral populations on the Great Barrier Reef using developed *Symbiodinium* microsatellites to infer the spatial connectivity of populations on reefs within and between the Central and Southern regions of the GBR [(a) AIMS/JCU] o Development of new microsatellite markers for Seriatopora *hystrix* on the GBR for parentage analysis in low diversity	1 March 2010	$25,000	$10,000	$10,000

For 2009/10 outputs only		Payments		
		JCU		AIMS
Milestones	**Date**	**MTSRF**	**RRRC**	**MTSRF**
populations [(a) AIMS/JCU] o Submission of a paper (with appropriate attribution of MTSRF funding and a copy delivered to the RRRC) on high through-put multiplex oxidative stress gene expression method in on corals [(b) AIMS/JCU] o A report describing the results of Agilent oligonucleotide array testing [(b) AIMS/JCU] o Submission of a paper (with appropriate attribution of MTSRF funding and a copy delivered to the RRRC) on intra-colony variation in gene expression levels [(b)JCU/AIMS] o Completion of coral disease prevalence surveys at key sites that experienced thermal stress, consistent with model predictions of likely white syndrome outbreaks, during summer 2008/09. [(c) JCU] o Submission of a paper (with appropriate attribution of MTSRF funding and a copy delivered to the RRRC) that describes the disease-temperature model to predict the likelihood of white syndrome outbreaks in response to SST anomalies on the GBR. Outputs of model delivered to the e-Atlas [(c) JCU] o An initial report on regional scale variation in inshore reef susceptibility to coral-algal phase-shifts and ecosystem collapse. [(d,e) JCU] o Initiation of quantitative evaluation of herbivore abundances and ecosystem thresholds. [(d,e) JCU] o Collection of genetic material from fish populations using hierarchical sampling across multiple spatial scales to establish relevant scales of population connectivity [(f) JCU] o A report on status and trends in recovery of fish communities following ongoing recovery of coral habitats in the Central GBR [(f) JCU]				
Report 2 submission: • Final reports describing the outcomes of work conducted within each objective (above) including: o A report describing the small-scale population genetic structure of Lizard Island and Palm Island *S. hystrix* populations, a comparison of habitats (*i.e.* exposed vs. sheltered) and regions. [(a) AIMS/JCU] o A report describing: (a) the genotypes of *Symbiodinium* C2 within healthy and stressed (=bleached) colonies of *Acropora*	1 June 2010	$25,000	$10,000	$10,000

For 2009/10 outputs only		Payments		
		JCU		AIMS
Milestones	**Date**	**MTSRF**	**RRRC**	**MTSRF**
millepora from different reefs using *Symbiodinium* microsatellites developed under this project; (b) the temporal variation in the genetic composition of *Symbiodinium* assemblages hosted by corals; and (c) the impacts of coral bleaching on genetic variation in *Symbiodinium* [(a) AIMS/JCU] o Submission of paper (with appropriate attribution of MTSRF funding and with copies delivered to the RRRC) on testing the temperature-disease model in relation to white syndrome outbreaks on the GBR and throughout the Indo-Pacific and assessment of the vulnerability of corals to disease in relation to ocean warming. [(c) JCU] o A final report on the capacity of remotely sensed measures of water quality to predict spatial patterns in the prevalence and abundance of diseases like black band disease on the inshore Great Barrier Reef. [(c) JCU] o Completed field and experimental evaluation of algal ecosystem thresholds, modeling of coral algal phase shifts under different climate change scenarios; submit paper (s) for publication (with appropriate attribution of MTSRF funding and with copies delivered to the RRRC). Outputs of models delivered to the e-Atlas [(d,e) JCU] o A final report on vulnerability of GBR to climate change induced shifts in macroalgae distribution and abundance in relation to fish herbivory and present options for alternate management options. Spatial components of the report delivered to the e-Atlas. [(d,e) JCU] o A report on the relative roles of pre- versus post-settlement processes in limiting recovery of coral reef assemblages [(f) JCU] o Paper submitted (with appropriate attribution of MTSRF funding and a copy delivered to the RRRC) discussing patterns and processes of extreme spatial variation in recovery and resilience of fish and coral assemblages [(f) JCU] • Meta-data describing all data generated by MTSRF Project 2.5i.3 lodged on the e-Atlas				
Total Funding		**$100,000**	**$35,000**	**$50,000**

Project 2.5i.3 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$150,000	-	$150,000
RRRC*	$35,000	-	$35,000
AIMS	-	$200,000	$200,000
PEW Foundation	-	$4,000	$4,000
JCU	-	$250,000	$250,000
Total	**$185,000**	**$454,000**	**$639,000**

* RRRC contribution is specifically for Objective (c).

JCU Project 2.5i.3 Budget 2009/10

Item	MTSRF & RRRC	JCU & PEW Foundation – In Kind	Total Cost
Salaries	$85,000	$254,000	$339,000
Operating	$30,000	-	$30,000
Travel	$20,000	-	$20,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$135,000**	**$254,000**	**$389,000**

AIMS Project 2.5i.3 Budget 2009/10

Item	MTSRF	AIMS – In Kind	Total Cost
Salaries	$15,000	$115,000	$130,000
Operating	$35,000	-	$35,000
Travel	-	$85,000	$85,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$50,000**	**$200,000**	**$250,000**

PROGRAM 5i: CLIMATE CHANGE: UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE GREAT BARRIER REEF

Project 2.5i.4: Tools to support resilience-based management in the face of climate change

Project Leader and Host Organisation

Dr Scott Wooldridge, Australian Institute of Marine Science (AIMS)

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Scott Wooldridge	AIMS	Bayesian modeler	0.35
Dr Colette Thomas	CSIRO	Bayesian modeler	0.35
Prof. Iain Gordon	CSIRO	Ecologist	0.06

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA - climate change - water quality	Dr Paul Marshall Dr Laurence McCook Roger Beeden
DEWHA	Kevin Gale
Department of Climate Change	
Queensland Office of Climate Change	
DERM	
AMPTO	Col McKenzie
QTIC	Daniel Gschwind

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

In order to effectively manage the resources of the Great Barrier Reef under climate change, information from many sources must be integrated in such a way that the risks faced and how they vary through time and space can be made explicit. A critical step in meeting this challenge is the development of spatially explicit, sub-regional scale information about the risks posed by climate change and variability in resilience. Once these risks are understood, it is then necessary to build management tools that facilitate the optimum use of management resources under conditions of considerable uncertainty. This project has two objectives that will enable it to make considerable advances beyond our current understanding of the risks of climate change and how best to manage these resources in the face of climate change. These objectives include: (a) an investigation of the risks to and resilience of the GBR social-ecological system (SES) to climate change, and (b) the development of integrative knowledge for prioritising management responses to climate change. The research in this project has been developed in close collaboration with

managers who need this information and tools. These managers will be part of this project throughout to ensure the outputs produced maximise potential outcomes for more effective management of the Great Barrier Reef.

Key Objectives:

(a) Investigate the risks to and resilience of the GBR social-ecological system (SES) to climate change.

(b) Develop integrative knowledge for prioritising management responses to climate change.

Project / Task Methodology

Objective (a): Investigate the risks to and resilience of the GBR social-ecological system (SES) to climate change

Climate change is acknowledged as one of the most serious threats to the future of coral reef ecosystems and their management, and there is an urgent need to identify and implement meaningful management responses. While the causes of climate change are beyond the direct influence of management agencies and individual stakeholders, a range of options are emerging for minimising its impacts on the ecosystem and the industries and regional communities that depend on it. A critical step for progress in meeting this challenge is the development of spatially explicit, sub-regional scale information about the risks posed by climate change and variability in resilience. This project will provide this information by investigating the risks to and resilience of key elements of the GBR social-ecological system (SES) to climate change. This will enable managers to incorporate climate-related threats into future management policies and activities, most of which are spatially explicit. It will also enable managers and stakeholders to identify areas where ecological or socio-economic values are most at risk. For example, the outcomes of this research might guide the distribution of RWQPP resources toward catchments where adjacent reefs are more susceptible to damage from coral bleaching. A priority list of target components of the GBR SES will be developed in consultation with end-users and data providers, and risk maps developed for each. This will provide an essential resource for end-users to develop feasible and defensible strategies in response to the threat of climate change.

Outcomes of this investigation will be presented as maps of risk and resilience of priority elements of the GBR SES and will be incorporated into the e-Atlas for the GBR (Project 1.1.5). Spatial analysis and modelling of key system variables (and causative interactions) will generate GIS map layers describing:

- Physico-chemical drivers affected by climate change (hazard);
- Synergistic (non-climate) stressors, e.g. water quality (interactions);
- Distributions of key elements of the GBR social-ecological system (exposure); and
- Susceptibility of elements to climate change (sensitivity)

Temporal projections of identified spatial patterns (hazard, interactions, exposure, sensitivity) will be generated on the basis of plausible climate change scenarios, adaptation measures and management activities.

Objective (b): Develop integrative knowledge for prioritising management responses to climate change

The outcomes of objective (a) will provide critical new insights into spatial variability of climate change risk. However, the need remains for a basis for prioritising the allocation of limited management resources among the range of issues presented by climate change. An integrative modelling approach, based on Bayesian belief networks (BBNs), will be used to represent the dynamic linkages and interdependencies of the many components of the GBR SES, and examine their vulnerability to climate change and their responsiveness to different management interventions. This approach will involve active participation from end-users and stakeholders through a series of workshops to define the scope of the model, its conceptual elements and links, and the format of scenarios or outputs. The model will enable end-users to test alternative scenarios for future climate, management actions and adaptation measures. This will add fundamental capacity to the ability of managers to test the cost-benefit ratio of alternative management responses as a basis for identifying strategies that deliver the best outcomes at the lowest cost. For example, reef managers might use the model to decide whether to prioritise investment toward restoring water quality or excluding human activities from key refugia for important reef species, policy makers might use the model pre-emptively to explore system-wide economic repercussions of management alternatives.

In order to investigate the risks to and resilience of key elements of the GBR SES to climate change, an agreed set of key elements first needed to be identified (*Objective a*). In consultation with end-users and data providers, priority components of the GBR SES were identified for further investigation and model representation under *Objective b*. The project initially aimed to quantify the effects of changing the configuration land use and land practice change on end-of-river water quality. However, early discussions with end-users and stakeholders confirmed that a more holistic account of the GBR SES was preferred. This was the result of the recognition that, although terrestrial linkages to marine ecology were useful and informative, the GBR SES did not stop at the Reef, but also contained an entire sector of reef-dependent industries, including for example tourism, recreational fisheries and commercial fisheries. The interdependence of agricultural and reef-dependent industries has been somewhat overlooked in previous quantitative analyses of the GBR SES. The aim of the CSIRO project, therefore, focussed on developing a proof-of-concept model capable of explicitly representing and, where possible, quantifying the key relationships between three GBR SES sectors; the agricultural industry, the coral reef, and the reef-based tourism industry. The model will be capable of resolving cross-sectoral changes in productivity linked to Reef health. If the trialled approach is successful, economic trade-offs can be explored across industries at the catchment level.

The change of focus from refining agricultural cost-effectiveness options to developing an integrated cross-sectoral systems model required a change in research approach. This is because management/policy interventions implemented in one sector of the GBR SES can cascade through to other sectors in unexpected ways. The CSIRO component aims to determine whether such cascades can be modelled in a way that can support policy development for community and environmental risk minimisation.

The change of tack required the project to be re-scoped; re-scoping activities were undertaken in close consultation with Reef managers in ARP3. These discussions identified reef tourism as the key component of the GBR SES, which needed to be linked into the project via an integrated systems model. The focus of the model was identified in ARP3 as the identification and quantification of key relationships between coral bleaching and tour operator income for reefs exposed to the Tully River flood plume. The model links to the coral bleaching model also being developed in this project (by Wooldridge), and allows a mechanism for assessing changes to system-level income resulting from policy interventions

in land management practices for sugar cane by linking to the model developed in MTSRF Project 3.7.5. Ensuing work under ARP3 succeeded in collaboratively developing a conceptual framework and draft BBN model structure adequate to meet these objectives.

Under the new focus, the BBN will help decision-makers understand the socio-economic trade-offs associated with managing for resilient reef communities given the threat posed by climate change. The AIMS component of the project will develop a model that quantifies the probability of severe coral bleaching events with climate-driven increases in surface ocean temperatures, and its synergistic links to GBR water quality. Improved inshore water quality requires the adoption of improved land practices in the catchment, which may incur considerable cost to the agricultural industry, as modelled in Project 3.7.5. However, this cost is countered by the associated benefit of safeguarding future reef tourism as modelled in the CSIRO component of Project 2.5i.4. The CSIRO component of the project will develop a prototype model capable of investigating these key system linkages.

The BBN will, therefore, formalise a socio-ecological cost-benefit analysis within a risk assessment framework. This aids the difficult task of prioritising alternative management actions. The complexity of the problem represents a challenging modelling task with a large envelope of solutions needing to be represented, each with its own scale and configuration of 'wins' and 'losses' across diverse system sectors. To simplify the modelling task, in ARP3 we specifically targeted key elements of the reef, agriculture, and tourism sectors and then focused on developing the most parsimonious set of cross-sector linkages to generate an integrated systems model.

The diverse nature of the individual sectors presents a major challenge for model construction, not least because the causal (i.e. dependence) relationships within individual sectors exist at different levels of understanding and scientific development, as do the relationships between the separate sectors. Furthermore, the data that captures the functional behaviour of each sector (as well as cross-sector interactions) exists as an eclectic mix of simulated, empirical and subjectively-derived information. Fortunately, the adopted BBN approach is capable of resolving these system domain and data uncertainties in a transparent fashion, which includes the assigning of error estimates for the alternate system trade-off scenarios. By making these trade-off uncertainties explicit, the resultant framework will provide decision-makers with a rational (i.e. quantitative) method to resolve catchment level questions, such as:

- For a given reef protection target, what are the costs to industry and how are they distributed across sectors?
- Which reef protection target provides the lowest risk and maximum benefit for the local community?
- What are the risks and benefits of maximum and 'do nothing' reef protection targets, and how are these risks and benefits distributed?
- How soon must reef protection targets be realised in order to maximise cross-sector benefits?
- Can win/win strategies be pursued with acceptable levels of certainty?
- Are the economic benefits to tourism likely to be large enough to balance economic losses to agriculture?
- Are economic losses in any sector likely to exist at levels that substantially reduce community wellbeing?
- What are the most influential system components, and are they amenable to policy development?

The CSIRO component of the project will, therefore, provide a model that allows for the exploration and evaluation of the economic outcomes to reef-based tourism of terrestrial landscape management options for reef protection. The model will take the principal attributes of coral ecology, agro-ecology, and socio-economic, processes and dynamics into account. In ARP3 the model structure was developed through participatory workshops with scientists, end users and stakeholders.

Under current funding arrangements, our focus in ARP4 will be to finalise model parameterisation and stakeholder evaluation. This requires the identification and extensive consultation with all relevant data custodians. The model will provide, for the first time, an explicit representation and quantification of the key cross-sectoral linkages related to the issue of climate-induced coral bleaching and reef protection. This GBR SES model not only allows a range of stakeholders to develop a common understanding of the system at the catchment scale, but also provides a potential way forward for future regional scale modelling tasks. Furthermore, the model delivers a framework for integrating diverse data and knowledge for the MTSRF program generally.

Once parameterised, the model will provide a powerful tool for policy makers, researchers and managers to reason about system connectivity and its potential responses to resource use conflicts. Parameterisation will include sourcing and utilisation of as much of the available, relevant, extant data and knowledge. Data and knowledge will be collected in ARP4 by:

- Reviewing the model structure with key knowledge custodians not already involved in model development, e.g. local tour operators and industry representatives;
- Identifying likely data and knowledge custodians within and external to the MTSRF, and arranging data access and use permissions;
- Parameterising the model with all available data, and identifying critical data gaps; and
- Revisiting the custodial knowledge-holders for these critical gaps, and eliciting their knowledge.

Evaluation processes will also be undertaken to ensure the parameterised model is reasonable and relevant. This will be achieved by:

- Eliciting critical scenario suites from end-users;
- Evaluating the model with specialist team members using the preferred scenarios; and
- Performing a sensitivity analysIsland

Should additional funding be made available, the parameterised and evaluated model will be analysed to generate a handful of additional outcomes, including:

- Identification of the system variables most influential upon identified endpoints (e.g. income, intention to return, intention to recommend to others);
- Scenario analysis of target variables; and
- Publication in a peer-reviewed journal.

A model documentation report will be provided under the current funding arrangements.

Project Outputs/Outcomes

Linking water quality and coral bleaching sensitivity (Objectives a, b)

The project has delivered new insight into how land management strategies that improve reef water quality can help to increase the future survivorship of inshore coral reefs given the threat posed by climate change. The associated development of decision support tools has enabled: (i) spatial mapping (identification) of regional areas that are most vulnerable to the synergistic interaction of poor water quality and thermal stress, and (ii) scenario-based analysis to determine the level of (catchment-specific) improvement in end-of-river water quality needed to ensure the continued persistence of productive, hard-coral dominated reefscapes. The work has been published as three peer-reviewed journals articles, and several research reports.

In this final year of the project (ARP4), new model scenarios will be undertaken in which future warming projections are based on global CO_2-stabilisation (450ppm and 550ppm) strategies. These stabilisation scenarios will be compared against a non-mitigation ('business-as-usual') CO_2 scenario. This new analysis will provide a framework to consider the combined benefit of 'local' and 'global' management intervention strategies in mitigating the future bleaching risk on the inshore reefs of the GBR.

Evaluating socio-economic and environmental tradeoffs (Objective a, b)

This project has developed a prototype framework for a Bayesian belief network (BBN) that provides catchment-to-reef integration of previously unlinked components of the GBR social-ecological system. The completed model will provide decision-makers with a rational (i.e. quantitative) method to resolve difficult catchment level questions relevant to policy development. BBN development has focused on a critical gap in catchment-to-reef research i.e., the effects of climate-driven reef change on reef-dependent industries, using tourism as a case study. This reef tourism BBN draws upon results generated in Projects 3.7.5 and 2.5i.4 and integrates data and expert judgment across five domains; agronomics, tourism, hydrology, economics and coral reef ecology.

The reef tourism BBN links reef condition with the reef tourism economy. Several studies have linked recreational welfare metrics with reef damage, however understanding of the quantitative relationship that exists explicitly between coral bleaching and tourism is in its infancy. A workshop was required to clarify and represent in the BBN mechanisms and sensitivities for several key relationships. These included linking; coral bleaching recurrence with reef condition, reef condition with tourist demand, and tourist demand with the tourism economy. The workshop with experts in reef ecology and tourism produced a conceptual framework, which was later verified against literature sources. The work conducted thus far has resulted in one peer-reviewed publication and several conference presentations.

During ARP4, data collection and upload will be completed and a sensitivity analysis performed for key variables. The implications of the sensitivity analysis results will be framed within the context of model certainty, knowledge gaps, and relevance to the profitability of future research investment. Two future scenarios will be identified and analysed. Model outcomes will be presented at an international conference, and published in at least one respected peer-reviewed journal.

There is limited funding in ARPF4 to analyse the full range of relevant questions. The model will help to resolve scientific research questions such as:

- What are the key sectors of the catchment with regard to reef health, how are they related, and with what certainty are they understood?

- What are the critical future scenarios for end-users? How do they play out in the model?
- What are the data/knowledge gaps in the system?
- Does the proof-of-concept sufficiently represent the key effects of climate-change on the GBR SES?
- What are the most influential variables of the modelled system to reef tourism income, and how might future research be most effectively invested?

Evaluation of the socio-economic impacts of climate change on the GBR (Objective a)

The project has delivered an integrated assessment of the potential socio-economic impacts of climate change (specifically coral bleaching) on the Great Barrier Reef (GBR) in Queensland, Australia. The assessment covers three research phases, these being:

(i) A literature review of:
   - Published research on the known and anticipated biological and productivity changes on coral reefs due to climate change;
   - The projected impacts of climate change on the GBR, specifically; and
   - An analysis of socioeconomic impact assessment methods that could potentially be applied to assess the climate change impacts (coral bleaching) on the GBR;

(ii) A socio-economic characterisation for three regions in the GBR catchment (Cairns, Townsville and Mackay-Whitsunday); and

(iii) The results of focus group workshops (with regional planners and local Government), together with a business survey and with detailed phone interviews (for businesses in target regions), which aimed to address three key questions:
   - What is the current knowledge of, and likely impacts from, climate change on reef based communities? (via the literature review);
   - How are communities currently placed with regard to potential risk and response? (via the socio-economic characterisation); and
   - What are the perceived threats to the community and businesses and what are current stakeholder attitudes to risk and response to climate change? (via business surveys and focus groups). Assess the socioeconomic implications of climate change on the GBR.

The integrated assessment has been published as part of the MTSRF Research Report Series[10]. No further socio-economic assessment will be undertaken in ARP4.

[10] Miles, R. L., Kinnear, S., Marshal, C., O'Dea, G. and Greer, L. (2009) *Assessing the socio-economic implications of climate change (coral bleaching) in the Great Barrier Reef catchment: Synthesis Report*. Report to the Marine and Tropical Sciences Research Facility. Reef & Rainforest Research Centre Ltd (147pp.).

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a, b)	For the reefs under the influence of the *Tully-Murray* flood plume, model the envelope of future bleaching impacts based on global atmospheric CO_2-stabilisation at 450 ppm and 550 ppm. Compare the results with a non-mitigation ('business-as-usual') CO_2 scenario [AIMS]	July 1 2009 – June 30 2010
(a, b)	For the inshore reefs between *Townsville* and *Cooktown*, model the envelope of future bleaching impacts based on global atmospheric CO_2-stabilisation at 450 ppm and 550 ppm. Compare the results with a non-mitigation ('business-as-usual') CO_2 scenario [AIMS]	
(a, b)	Submit for peer-review a manuscript (with appropriate attribution of MTSRF funding) that considers the extent to which 'local' and 'global' management intervention strategies can help to mitigate future bleaching risks on the inshore reefs of the GBR [AIMS]	
(a, b)	Present interim results of reef tourism BBN at an international conference (with appropriate attribution of MTSRF funding) [CSIRO]	
(a, b)	For critical nodes, elicit conditional probabilities from experts. [CSIRO]	
(a, b)	Identify scenarios for analysis in the prototype. [CSIRO]	
(a, b)	Evaluate prototype BBN performance [CSIRO]	
(a, b)	Using sensitivity analysis, determine the areas of the modeled system most influential to tour operator income[11]. [CSIRO]	
(a, b)	Using scenario analysis, identify how the system will respond under selected future change scenarios[1] [CSIRO]	
(a, b)	Publication of the key relationships identified in the prototype reef condition-reef tourism BBN (with appropriate attribution of MTSRF funding)[1] [CSIRO]	

Project 2.5i.4 Milestone Payments 2009/10

For 2009/10 outputs only		MTSRF	
Milestones	**Date**	**AIMS**	**CSIRO**
Signing of contract		$12,500	$14,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Submission of Progress Report (1), which outlines: • For the reefs under the influence of the Tully-Murray flood plume, model the envelope of future bleaching impacts based on global atmospheric CO_2-stabilisation at 450 ppm and 550 ppm. Compare the results with a non-mitigation ('business-as-usual') CO_2 scenario [AIMS]	15 Nov 2009	$15,000	$14,400

[11] Contingent upon additional funding. Milestone delivery dates will need to be reviewed if additional funding is procured.

For 2009/10 outputs only		MTSRF	
Milestones	**Date**	**AIMS**	**CSIRO**
• Delivery of model outputs of future bleaching risks to the e-Atlas (Project 1.1.5) • Present interim results of reef tourism BBN at an international conference (with appropriate attribution of MTSRF funding) [CSIRO] • Plan of communication activities/products for year four and summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable, schedule of future communication activities AIMS, CSIRO]			
Submission of Progress Report (2), which outlines: • For the inshore reefs between Townsville and Cooktown, model the envelope of future bleaching impacts based on global atmospheric CO_2-stabilisation at 450 ppm and 550 ppm. Compare the results with a non-mitigation ('business-as-usual') CO_2 scenario [AIMS] • Delivery of model outputs of future bleaching risks to the e-Atlas (Project 1.1.5) • For critical nodes, elicit conditional probabilities from experts, and identify scenarios for analysis in the prototype [CSIRO] • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable [AIMS, CSIRO]	15 Feb 2010	$15,000	$15,400
Submission of Report (3), which outlines: • Submit for peer-review a manuscript (with appropriate attribution of MTSRF funding) that considers the extent to which 'local' and 'global' management intervention strategies can help to mitigate future bleaching risks on the inshore reefs of the GBR [AIMS] • Evaluate prototype BBN performance and refine where necessary [CSIRO] • Using sensitivity analysis, determine the areas of the modeled system most influential to tour operator income [CSIRO] • Using scenario analysis, identify how the modeled system will respond to future change[2] [CSIRO] • Publication of the key relationships identified in the prototype reef ecology and tourism BBN (with appropriate attribution of MTSRF funding) [CSIRO] • Report to MTSRF including documentation of all relevant modeling processes and components completed with the funding provided • Final summary of communication activities	15 June 20010	$7,500	$9,200

For 2009/10 outputs only		MTSRF	
Milestones	**Date**	**AIMS**	**CSIRO**
undertaken through the course of year 4 of the project (with appropriate attribution of MTSRF funding) [AIMS, CSIRO] • Meta-data describing all data generated by MTSRF Project 2.5i.4 lodged on the e-Atlas [AIMS]			
Total MTSRF Funding		**$50,000**	**$53,000**

* Total excludes funds held for Visual Documentation.

Project 2.5i.4 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$103,000	-	$103,000
MTSRF Visual Documentation*	$2,000	-	$2,000
AIMS	-	$45,500	$45,500
CSIRO	-	$38,000	$38,000
Total	**$105,000**	**$83,500**	**$188,500**

* A total of $2,000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

AIMS Project 2.5i.4 Budget 2009/10

Item	MTSRF	AIMS – In Kind	Total Cost
Salaries	$40,000	-	$40,000
Operating	$8,000	-	$8,000
Travel	$2,000	-	$2,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$45,500	$45,500
Total	**$50,000**	**$45,500**	**$95,500**

CSIRO Project 2.5i.4 Budget 2009/10

Item	MTSRF	CSIRO – In Kind	Total Cost
Salaries	$53,000	$18,000	$71,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$14,500	$14,500
Total	**$53,000**	**$32,500**	**$85,500**

PROGRAM 5II: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE WET TROPICS RAINFORESTS

Project 2.5ii.1: Regional climate projections for tropical rainforest

Project Leader and Host Organisation

Dr Ramasamy Suppiah, CSIRO

Administrative arrangements: Dr Penny Whetton has stepped down and Dr Ramasamy Suppiah has taken over the Project Leadership.

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Ramasamy Suppiah	CSIRO	Climatologist	0.26
Dr Janice Bathols	CSIRO	Computer Scientists	0.04
Dr jim Ricketts	CSIRO	Computer Scientists	0.10
Dr Deborah Abbs	CSIRO	Extreme events climatologist	0.10
Dr John McGregor	CSIRO	Climate modeller	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
JCU	Steve Williams and others
Queensland Herbarium, Environmental Sciences, EPA	Arnon Accad

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

Project 2.5ii.1 will develop a high-resolution software tool, *OzClim*, for the North Queensland region to a spatial resolution of fifteen kilometers using simulations from CSIRO high resolution model and IPCC AR4 global climate models with multiple scenarios so that uncertainty in future climate change projections can be represented. It is closely linked to the equivalent project of the marine impacts program, and both projects could be considered as two parts of a single package. The climate change projections in both projects started from the common starting point of the global climate models but different techniques are required to provide regional detail in the two realms. There is also linkage at the level of data delivery to impact researchers.

Key Objectives:

(a) Utilise the output of global climate models to prepare an assessment of the range of likely changes in climate means relevant to tropical rainforests, e.g. mean, minimum and maximum temperature, humidity, rainfall, seasonality of rainfall, cloud base height, lapse rate and solar radiation. Consider also extreme precipitation and winds associated with tropical cyclone occurrence.

(b) Provide fine resolution detail in projected climate change for the region. Enable an assessment to be made of how local topographical variations impact on the patterns of projected future climate change.

(c) Provide climate change data tailored for use in impact assessment and for more general MTSRF communication.

Project / Task Methodology

Objective (a): Utilise the output of global climate models to prepare an assessment of the range of likely changes in climate means relevant to tropical rainforests

- Analysis of existing global climate models' simulations to produce probability based annual and seasonal climate change projections for the MTSRF region.

Objective (b): Provide fine resolution detail in projected climate change for the region. Enable an assessment to be made of how local topographical variations impact on the patterns of projected future climate change

The CSIRO CCAM model will be run under current and enhanced greenhouse conditions nested in simulations with six global climate models: CSIRO Mark 3.5, GDFL 2.1. GFDL 2.0, ECHAM5, HADCM3 and MIROC-Med. The current climate simulations will be used for validating the model against regional observed climate.

- Analysis would then be undertaken of a climate simulation focused on the tropical rainforest region at a horizontal resolution of fifteen kilometres. This resolution is required to obtain a reasonable representation of regional topographical effects on climate.
- Existing high-resolution simulations of tropical cyclone events will be analysed for the North Queensland region.
- By using both multiple models and high-resolution simulation, issues of uncertainty due to model-to-model differences and how large-scale changes are expressed at fine spatial scale will be addressed.

Objective (c): Provide climate change data tailored for use in impact assessment and for more general MTSRF communication

- Interact with users of climate change products to determine the climate change information that is required and the form in which the information is required.
- Provide data in tailored form. This is likely to involve the development of a regional and project specific version of CSIRO's OzClim software for the region and the needs of the impact assessment users. OzClim provides climate scenarios for user-selected time slices and emission scenarios and combines these with a high-resolution observed database. Output of OzClim is in the form of regional maps and data files.

Project Outputs/Outcomes

1. Final report on regional climate change projections for the MTSRF region.
2. Final report on high resolution climate modelling under enhanced greenhouse conditions over the MTSRF region. This includes results from six ensemble runs listed here. This report also includes changes to tropical cyclone activity over northeast Queensland.
3. A web-based OzClim version specifically suitable for the MTSRF region. This includes relevant boundaries and some other features on map and export data using web GIS services.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a.1)	Further analysis of AR4 global and regional climate models to produce climate change projections for the MTSRF region. Provide the final report on climate change projections for the MTSRF region	June 2010*
(a.2)	Analysis of changes humidity and rainfall, cloud base height, lapse rate and solar radiation in the tropical rainforest region	June 2010
(b.1)	Complete the 60 km simulations over Australia	August 2009
(b.2)	Complete the 20 km simulations over North Queensland as driven by two host GCMs: CSIRO Mark 3.5 and GDFL 2.1.	December 2009
(b.3)	Complete the 20 km simulations over North Queensland as driven by the remaining four GCMs: GFDL 2.0, ECHAM5, HADCM3 and MIROC-Med.	May 2010
(b.4)	Provide a report on the ensemble of downscaled simulations	June 2010
(b.5)	(1) Use outputs from six new CCAM climate change simulations (see b.2 and b.3) to identify tropical cyclone-like vortices in these models and investigate changes in frequency, region of occurrence and intensity. (2) Compare and contract these changes with those identified in earlier studies. (3) Prepare probabilistic projections of changes in TC occurrence based on the ensemble of climate change simulations that have been undertaken for NE Australia.	June 2010
(c.1)	Incorporation of dynamically downscaled climate projections within a representative selection of host GCMs at 15km resolution.	December 2009
(c.2)	Ability to overlay relevant boundaries and some other features on map and export data using web GIS services. Map navigation tools, such as “zoom in” and “zoom out”, using web GIS services.	June 2010

* An assessment of 23 AR4 climate models was completed in year one and mean temperature and rainfall projections for 2030 and 2070 have been prepared for the rainforest region. These tasks will continue for coming years with the analysis of high resolution climate model simulations.

Project 2.5ii.1 Milestone Payments 2009/10

For 2009/10 outputs only Milestones- all CSIRO responsibilities	Date	MTSRF CSIRO
Signing of contract	July 2009	$24,500
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	
Verbal Progress Report to Operations Committee: • Progress update of activities associated with objectives a-c including: findings from model analysis – consisting of new regionally focused analysis of existing model runs, data assembled for climate change simulations, end users approached and climate change scenario needs identified. • Plan of communication outputs and products for the last year and summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable.	2009/10	-
Verbal Progress Report to Operations Committee: • Report on progress of high resolution climate modeling at 20 km resolution, progress on tropical cyclone analysis and OzClim tool kit.	15 Nov 2009	$24,500
• Draft report on regional climate change projections for the MTSRF region. • Report on progress on 20 km high resolution run over North Queensland using boundary conditions from CSIRO Mark 3.5 and GFDL 2.1 • Progress report on OzClim	15 Feb 2010	$24,500
• Final report on outcomes of the current climate simulation models for the Region developed/progressed during the contract period (with attribution of MTSRF funding). • Report on consultation undertaken with users and final summary of communication activities undertaken through the course of the project. • Final report on regional climate modeling under current and future climates of the MTSRF region. This report also includes results for tropical cyclones over North Queensland (with attribution of MTSRF funding) • Final version of the web-based OzClim version specifically suitable for the MTSRF region (with attribution of MTSRF funding).	15 June 2009	$24,500
Total MTSRF Funding		**$98,000**

Project 2.5ii.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$98,000	-	$98,000
MTSRF Visual Documentation*	$2,000	-	$2,000
CSIRO	-	$100,000	$100,000
Total	**$100,000**	**$100,000**	**$200,000**

* A total of $2,000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

CSIRO Project 2.5ii.1 Budget 2009/10

Item	MTSRF Funds	CSIRO In-kind	Total Cost
Salaries	$64,000	$6,000	$70,000
Operating	$8,000	$12,000	$20,000
Travel	$8,000	$12,000	$20,000
Communication / Extension	$18,000	-	$18,000
Capital	-	-	-
Institutional overheads	-	$70,000	$70,000
Total	**$98,000**	**$100,000**	**$198,000**

PROGRAM 5II: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE WET TROPICS RAINFORESTS

Project 2.5ii.2: Climate change: Scaling from trees to ecosystems

Project Leader and Host Organisation

Assoc. Prof. Michael Liddell, James Cook University (JCU)

Project Team 2009/10

Title	Organisation	Role	FTE
Assoc. Prof. Michael Liddell	JCU	Atmospheric Chemist	0.25
Dr Will Edwards	JCU	Ecologist	0.1
Dr Paul Nelson	JCU	Soil Scientist	0.05
Professor Caroline Gross	UNE	Plant Reproductive Ecologist	0.1
Professor Nigel Stork	Uni Melbourne	Entomologist	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
MTSRF Project 1.2.1	James Butler
MTSRF Project 2.5ii.4	Steve Williams
SkyRail	Max Shepherd
Discovery Centre	Ron Burkett

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

Most of the research discussed in this Program is at the landscape level with a range of sites being used to provide the data for the modelling work. Project 2.5ii.2 will look in much more detail at three sites (tropical lowland rainforest) and determine how plants and invertebrates respond physiologically and phenologically, (e.g. fruiting, flowering) to natural climate variability and how trees and forests as a whole respond in terms of carbon and water use. This information will be used to indicate the sensitivity of ecosystems of this type to climate change. This research continues to be carried out at the Australian Canopy Crane research facility, additional project work is carried out at the Daintree Discovery Centre and at the SkyRail rainforest cableway. The project takes advantage of over $50 million in infrastructure and ten years of existing data sets.

Key Objectives:

(a) To improve our understanding of the factors influencing the variability in carbon and water fluxes from the rainforest through a long-term study in parallel with microclimate measurements.
(b) To monitor the differential effect of climate change on productivity of different floristic elements of a taxonomically diverse rainforest canopy – essential baseline data for predictive and scaling models of ecosystem productivity.
(c) To determine the fluxes of carbon and water below ground, and the factors controlling these fluxes, including the influence of climate.
(d) To describe flowering / fruiting phenology in lowland rainforest and determine correlations with fluctuations in climatology.
(e) To understand how invertebrate resource use fluctuates in relation to seasonal local climatic variables and link this to ecosystem productivity and plant phenology.

Project / Task Methodology

Objective (a): To improve our understanding of the factors influencing the variability in carbon and water fluxes from the rainforest through a long-term study in parallel with microclimate measurements

Eddy covariance (EC) methods are used to continuously measure carbon and water fluxes from the footprint surrounding the Crane tower. The EC methods use equipment installed in March 2001. A full suite of microclimate instrumentation is present on site (Automatic Weather Station; AWS) and on the crane tower (radiometry). A second eddy covariance system at the Discovery Tower, Cow Bay is similarly equipped to the Canopy Crane tower system and is being used to investigate the reproducibility of the flux results.

Objective (b): To monitor the differential effect of climate change on productivity of different floristic elements of a taxonomically diverse rainforest canopy – essential baseline data for predictive and scaling models of ecosystem productivity

Dendrometer measurements of stem incremental growth, litter trap and Leaf Area Index (LAI) measurements continue to monitor and compare carbon storage and turnover across species. Elemental analysis of canopy vegetation to correlate with litter turnover and soil mineralisation continues.

Objective (c): To determine the fluxes of carbon and water belowground, and the factors controlling these fluxes, including the influence of climate

Measurements of the soil water regime in the unsaturated zone (TDR probes and gypsum blocks); and saturated zone (piezometers); Concentrations of C and nutrients in water moving through profile. Measurement of the biophysical controls on carbon mineralisation in soil and leaching losses using ^{13}C NMR.

Objective (d): To describe flowering / fruiting phenology in lowland rainforest and determine correlations with fluctuations in climatology

Qualitative data on flowering and fruiting episodes (tree and species level) will be scored from digital images at set times throughout the census period using the SkyRail aerial transect. This data set will then be evaluated against climatic information for the same period. The work will provide the first long term assessment of community flowering resources and the strategies used by species at the community level in response to climatic variation.

Objective (e): To understand how invertebrate resource use fluctuates in relation to seasonal and local climatic variables and link this to ecosystem productivity and plant phenology

Develop an understanding of the resource related causes of inter-and intra-annual variation in insect populations and how they relate to trends in plant phenology, ecosystem productivity and climate variability.

Project Outputs/Outcomes

Assoc. Prof. Michael Liddell : Objective a	The major outcome will be a detailed report on the fluxes of carbon and water from lowland rainforest in the Daintree and how these fluxes respond to climatic change. The output will be a paper in a well recognised international journal.
Dr Will Edwards : Objective b	A description of intra- and inter-annual changes in forest biomass in response to climatic fluctuations will be the major outcome. This will be developed into a paper.
Dr Paul Nelson: Objective c	A comprehensive analysis of forest soil water availability will be a major outcome of this objective. The soil nutrient status and carbon dynamics of the soil will also be written up as a paper as an output from this objective.
Assoc. Prof. Caroline Gross : Objective d	Phenological signals of climate change are the desired outcome of this project. Necessarily a long term data set is required before this can be accomplished. The major outcome of the first year of data collection will be the establishment of a phenological database for both SkyRail and the crane site. A paper will be submitted on the methodology developed using digital technology as an output.
Professor Nigel Stork: Objective e	Insect community response to available biomass will be the major outcome of this sub-project. The available biomass will be coupled to variability in climatic conditions. Papers will be developed from this work as the output.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)	*Atmosphere:* Completion of collection of the biophysical data (fluxes of carbon, water linked to microclimate variables) required in understanding forest level response to climatic drivers. Comparisons will be made between the two flux sites – Cape Tribulation and Discovery Tower.	June 2010
(b)	*Plant Productivity:* Collate 2009 dendrometer and litter trap data and analyse. Analyse 2009 canopy LAI data.	June 2010
(c)	*Soil:* Monitor soil water content and groundwater levels and calculate water uptake throughout the season. Quantify C fluxes. Determine nature of organic C in litter and soil and the effect on turnover.	June 2010
(d)	*Phenology:* Identify core sampling trees along the SkyRail transect using the data collected in 2009. Complete digital data collection for the MTSRF period. Provide final year of analysis on reproductive phenology patterns.	June 2010
(e)	*Fauna:* Completed collection of beetles inhabiting leaf litter, fruits and logs. The temporal variation of the beetle assemblages and how they relate to the temporal variation in the quality of organic input (e.g. leaf litter, woody debris, fruit, flower etc) will be developed.	June 2010

Project 2.5ii.2 Milestone Payments 2009/10

For 2009/10 outputs only	Payments	MTSRF	Skyrail
Milestones	**Date**	**JCU**	**JCU**
• Signing of contract	2009/10	$25,000	$5,000
• Attendance by project leader at Operations Committee meetings (three meetings per year).	2009/10		
Submit Report 1, describing: • The seasonal fluxes of carbon and water from the Daintree rainforest in relation to climatic drivers (obj a). • The variations in rainforest tree productivity and water use efficiency (obj b). • Characterisation of water uptake and C turnover at the canopy crane site (obj c). • Characterisation of flowering / fruiting events in honological monitoring program (obj d). • Resource related fluctuations in insect populations inhabiting leaf litter on the ground and how they relate to ecosystem productivity, and resource quantity (obj e). • Plan of communication products and events for year four	1 Nov 2009	$38,000	-

For 2009/10 outputs only	Payments	MTSRF	Skyrail
Milestones	**Date**	**JCU**	**JCU**
and summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable.			
Submit Report 2, describing: • Ongoing work on seasonal fluxes of carbon and water from the Daintree rainforest in relation to climatic drivers (obj a). • Recent findings of work on the variations in rainforest tree productivity and water use efficiency (obj b). • Recent findings of water uptake and C turnover at the canopy crane site (obj c). • Characterisation of flowering / fruiting events in monitoring program (obj d). • Further findings from work on the resource related fluctuations in leaf litter insect populations on the ground and how they relate to the quality of organic input ecosystem status / productivity and climate variability (obj e). • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable.	16 March 2010	$30,000	-
Submit Report 3: • Final report on the seasonal variation in fluxes (fluxes of carbon, water) linked to microclimate variables in the Daintree (obj a). • A paper on fluxes of carbon and water and their inter-relationship with climate variability will be submitted for publication with attribution of MTSRF funding. • Final report on risks and threats to lowland rainforest canopy tree productivity under changing rainfall and temperature scenarios (obj b). We hope to use a circular statistical approach to characterise the pattern in leaf fall within and between years. Results of this study are expected to be analysed in conjunction with the results from the four dendrometer band census surveys. A paper will be submitted indicating changes in forest productivity in concert with microclimate with attribution of MTSRF funding. • Final report on the results of water uptake and C turnover measurements at the canopy crane site (obj c). A paper on water uptake in response to climatic factors and nature and fluxes of organic C in litter and soil will be submitted for publication with attribution of MTSRF funding. • Final report of the results on the annual variations in phenology over the SkyRail transect and correlations will be made with species also present at the Crane site (obj d). Paper to be submitted on digital capture of phenological data from an aerial cableway with attribution of MTSRF funding. • Final report on ground organic resource fluctuations and variations in insect populations. How insect population changes relate to: variations in the quality and quantity of resources, ecosystem status/ productivity and climate	1 June 2010	$25,000	-

For 2009/10 outputs only	Payments	MTSRF	Skyrail
Milestones	**Date**	**JCU**	**JCU**
variability will be examined (obj e). • Papers (with attribution of MTSRF funding) will be submitted on the following topics: 1) leaf-litter inhabiting beetles and seasonality; 2) ordinal profiles/guild composition of insects on different canopy microhabitats; and 3) body size differences in insects inhabiting different microhabitats. • Summary of communication activities undertaken through the course of final year of project, including any examples of application of the results by MTSRF projects, SkyRail and the Discovery Centre.			
Indicative MTSRF Funding		**$118,000**	**$5,000**

Project 2.5ii.2 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$118,000	-	$118,000
MTSRF Visual Documentation*	$2,000	-	$2,000
SkyRail Foundation / SkyRail	$5,000	$1,000	$6,000
JCU	-	$276,000	$276,000
Total	**$125,000**	**$277,000**	**$402,000**

* A total of $2,000 is held by RRRC for Visual Documentation for this project (see Theme 5).

JCU Project 2.5ii.2 Budget 2009/10

Item	MTSRF	JCU/UNE/UniMelb – In Kind	Total Cost
Salaries	$58,000	$82,000	$140,000
Operating	$51,000	$200,000	$251,000
Travel	$9,000	-	$9,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$118,000**	**$282,000**	**$400,000**

PROGRAM 5II: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE WET TROPICS RAINFORESTS

Project 2.5ii.3: Understanding climate change threat to ecosystems and ecological processes

Project Leader and Host Organisation

Dr David W. Hilbert, CSIRO

Project Team 2009/10 Indicative

Title	Organisation	Role	FTE
Dr David Hilbert	CSIRO	Ecological Modeler	0.23
Dr David Westcott	CSIRO	Vertebrate Ecologist	0.08
Dr Dan Metcalfe	CSIRO	Plant Ecologist	0.08
Ms Tina Lawson	CSIRO	Spatial analyst	0.23
Mr Andrew Ford	CSIRO	Botanist	0.12
Mr Dean Jones	CSIRO	Animal ecology technician	0.23
Mr Adam McKeown	CSIRO	Animal ecology technician	0.23
Dr Steve Goosem	WTMA	User input and advice	NA

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Steve Goosem
Alliance for Sustainable Tourism	Melinda Connally
Terrain NRM	Allan Dale, Rowena Grace
QEPA	Wolf Sievers

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

Project 2.5ii.3 uses a series of sites on an altitudinal transect and regional, existing forest plots to examine responses at the ecosystem and species level to climate change. This project takes advantage of existing data from twenty-five to thirty-five years of measurements in plots maintained by CSIRO. Most of the research in this project is at the landscape level with a range of sites being used to provide the data for modeling. This project will assess current and ongoing climate change impacts on ecosystems, identify how they might adapt under predicted climate change, identify key refugia and important landscape links, identify how climate change might interact with other threats, assess ecosystem resilience, and produce regional maps (projected to year 2050) outlining likely changes to North Queensland ecosystems given a variety of scenarios for future warming, responses of biota and management interventions.

This project has many links with several other MTSRF programs and projects.

Key Objectives:

(a) Assessment of current and ongoing climate change impacts

(b) Identify how ecosystems might adapt under predicted climate change, including identification of key refugia and important landscape links, and guidelines for design of refugia to allow for movement of organisms and persistence of gene pools.

(c) Identify how climate change and its primary impacts might interact with other threats – clearing, fragmentation, fire, urbanisation, weeds, zoonoses, storms and land uses – to impact on ecosystems, including identification of those which have the greatest potential for substantial impact.

(d) Identify how resilient North Queensland regional ecosystems are and how resilience can be enhanced within scenarios of increased climate variability.

(e) Produce regional maps (projected to appropriate temporal scales of relevance to MTSRF end users) outlining likely changes to North Queensland ecosystems given a variety of scenarios for future warming, responses of biota and management interventions. The specific climate change scenarios will be consistent with those used by all other projects in this program. Note that Hilbert is a participant in Project 2.5ii.1 where scenarios are being developed. The maps will be provided to all end-users to facilitate their management planning and actions.

Project / Task Methodology

Objective (a): Assessment of current and ongoing climate change impacts

- Assessment of forest structure, biomass and species composition. twelve 0.1 ha forest plots surveyed at regular (100 m) elevation intervals and coinciding as much as possible with MTSRF Project 2.5ii.4's existing altitudinal surveys of vertebrates. All trees >=10cm diameter at 1.3m height (dbh) enumerated, measured and identified to species. Full vascular plant surveys in each plot.
- Assessment of forest dynamics. Direct analysis of size-frequency distributions from CSIRO's long-term plots as well as this project's survey plots.
- Assessment of seed dispersal processes. On plots from above, undertake studies of seed dispersers and Identification of plant seed dispersal functional groups by elevation.
- The distribution of vectors of animal diseases and the diseases themselves. Standard mosquito traps and molecular biology methods (to detect avian diseases transmitted by arthropod vectors) coinciding with the altitudinal gradients used in above.
- Present changes and greatest threats to ecosystems. Analyses of results from and synthesis of previous research outputs.

Objective (b): Identify how ecosystems might adapt under predicted climate change, including identification of key refugia and important landscape links, and guidelines for design of refugia to allow for movement of organisms and persistence of gene pools

- Maps of refugia for forest types. Application of the forest distribution model to all of the Wet Tropics Bioregion at a fine scale of resolution using outputs from the climate scenarios project. Uncertainty analyses conducted by using results from the range of likely climate scenarios and GIS, landscape analysis techniques.
- Landscape links among refugia. GIS, landscape analysis techniques and network theory assessments of connectivity taking species movement and dispersal properties into account.
- Capacity of forest ecosystems to shift spatially. Methods similar to those above but applied more broadly to the entire bioregion.

- Suggestions for management interventions to conserve refugia and improve their connectivity. Synthesis of results.

Objective (c): Identify how climate change and its primary impacts might interact with other threats to impact on ecosystems, including identification of those which have the greatest potential for substantial impact

Objective (d): Identify how resilient North Queensland regional ecosystems are and how resilience can be enhanced within scenarios of increased climate variability

- Potential ecosystem impacts of altered distributions and prevalence of animal diseases. Spatial modeling of vector and disease distributions under many climate change scenarios using outputs from Project 2.5ii.1.
- Spatial identification of weed threats. Identification of weeds by altitude in plots established in Objective (a).
- Application of models and data developed in Project 2.5ii3.
- Model of forest distributions. The current model needs to be modified and updated to run on the newer, existing hardware and the different spatial extent of application in this project. As much as possible, the existing model, which is well tested, will be retained. Temporal projections will be of relevance to end users and agreed across the MTSRF.

Objective (e): Produce regional maps (projected to appropriate temporal scales of relevance to MTSRF end users) outlining key changes to North Queensland ecosystems given a variety of scenarios for future warming and responses of the biota

- Maps of projected forest environments. Application of the forest distribution model to all of the Wet Tropics Bioregion at a fine scale of resolution and using climate change scenarios from Project 2.5ii.1 as agreed upon by the end-users.
- Uncertainty analyses conducted by using results from the range of likely climate scenarios. Application of the forest distribution model to all of the Wet Tropics Bioregion at a fine scale of resolution and using outputs from the climate scenarios project.
- Maps of projected forest basal area and biomass. Uncertainty analyses conducted by using results from the range of likely climate scenarios.
- These maps will provide information to end-users that they can use to develop management procedures based upon climate refugia and landscape connectivity in future climates.

Project Outputs/Outcomes

Objectives	Deliverables	Approximate Date
Advice to managers concerning the present changes and greatest threats to ecosystems due to climate change	Report to managers (WTMA and Queensland EPA) on the present changes and greatest threats to ecosystems due to climate change	June 2010
Identification of landscape links among refugia in 2025, 2050, and 2100	Maps of landscape links among refugia in 2025, 2050, and 2100	December 2009
Recommendations for management interventions to conserve refugia and improve their connectivity.	Report on management interventions to conserve refugia and improve their connectivity	June 2010
Identification potential ecosystem impacts of altered distributions and prevalence of animal diseases due to climate change	Report on potential ecosystem impacts of altered distributions and prevalence of animal diseases due to climate change	December 2009
Maps of projected forest basal area and biomass in 2025 and 2050 based on a realistic range of climate scenarios	Maps and GIS layers	June 2010

Project Milestones 2009/10

Objective (from above)	Targeted Activity (from above)	Completion Date
Renewal of contract variation	Signing of a contract with variations	July 2009
• Identification of landscape links among refugia in 2025, 2050, and 2100 • Identification potential ecosystem impacts of altered distributions and prevalence of animal diseases due to climate change	• Maps of landscape links among refugia in 2025, 2050, and 2100 • Report on potential ecosystem impacts of altered distributions and prevalence of animal diseases due to climate change	December 2009
Update on progress	Presentation at a RRRC operations committee meeting	February 2010
• Advice to managers concerning the present changes and greatest threats to ecosystems due to climate change • Recommendations for management interventions to conserve refugia and improve their connectivity. • Maps of projected forest basal area and biomass in 2025 and 2050 based on a realistic range of climate scenarios.	• A report to WTMA and Queensland EPA on the present changes and greatest threats to ecosystems due to climate change. • A report to RRRC/MTSRF on management interventions to conserve refugia and improve their connectivity. • Maps and GIS layers provided to RRRC/MTSRF	June 2010

Project 2.5ii.3 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**CSIRO**
Signing of a contract with variations	July 2009	$35,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
• Report containing, 1) maps of landscape links among refugia in 2025, 2050, and 2100, and 2) potential ecosystem impacts of altered distributions and prevalence of animal diseases due to climate change with MTSRF attribution.	15 December 2009	$35,000
• Written Progress report on project activities to the RRRC	10 February 2010	$35,000
• A report to WTMA and Queensland EPA on the present changes and greatest threats to ecosystems due to climate change. • A report to RRRC/MTSRF on management interventions to conserve refugia and improve their connectivity. • Maps and GIS layers provided to RRRC/MTSRF. • Each report to include appropriate attribution of MTSRF funding.	5 June 2009	$42,000
Total MTSRF Funding		**$147,000**

Project 2.5ii.3 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$147,000	-	$147,000
MTSRF Visual Documentation*	$3,000	-	-
CSIRO	-	$142,318	$142,318
Total	**$150,000**	**$142,318**	**$292,318**

* A total of $3000.00 is held by RRRC for Visual Documentation for this project (see Theme 5).

CSIRO Project 2.5ii.3 Budget 2009/10

Item	MTSRF	CSIRO – In Kind	Total Cost
Salaries	$119,781	$15,615	$135,396
Operating	$13,511	-	$13,511
Travel	$13,708	-	$13,708
Communication / Extension	$3,000	-	-
Capital	-	-	-
Institutional overheads	-	$122,175	$122,175
Total	**$150,000**	**$137,790**	**$284,790**

PROGRAM 5II: CLIMATE CHANGE – UNDERSTANDING THE THREAT, ECOSYSTEM IMPACTS AND MITIGATION OF THE WET TROPICS RAINFORESTS

Project 2.5ii.4: Impacts of climate change on biodiversity

Project Leader and Host Organisation

Associate Professor Stephen Williams
Centre for Tropical Biodiversity and Climate Change, James Cook University.

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Associate Professor Stephen Williams	JCU	Project Leader, macroecology, biodiversity and climate change impacts	0.25
Professor Chris Johnson	JCU	Macroecology; phylogenetic analysis; extinction proneness analysis	0.1
Dr Jeremy Vanderwal	JCU (RAP funded)	Spatial analysis; GIS	0.1
Dr Andrew Krockenberger	JCU	Ecophysiology (thermal and desiccation tolerances, etc.)	0.2
Professor Steve Turton	JCU	Climatology; microclimates	0.1
Dr Lucas Shoo	JCU	Refugial ecology; thermal microhabitats; extinction proneness;	1.0
Vanessa Valdez Rameriz	JCU	Net primary productivity and relationships across altitude with biodiversity	1.0
Alex Anderson	JCU	Effect of climate variation on bird abundance and distribution	0.5
Andres Merino Viteri	JCU	Physiological tolerances in microhylid frogs	0.5
Collin Storlie	JCU	Field work, data management, management of insect sampling across region, datalogger downloads and maintenance	1.0

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
DEWHA	Ivan Lawler
WTMA	Ellen Weber, Steve Goosem
EPA	Paul Williams
Terrain NRM	Kirby Doak, Rowena Grace, Allan Dale
Alliance for Sustainable Tourism	Melinda Connolly

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

In conjunction with Project 2.5ii.3, this project will utilise a series of well-established sites on altitudinal and regional transects and existing forest plots to examine responses at the ecosystem and species level to climate change. Both projects will take advantage of existing data from ten to twenty-five years of collections at these sites / plots by CSIRO, JCU and through the Rainforest CRC. The aim of Project 2.5ii.4 is to assess the potential of wet tropics species to adapt to climatic change through ecological and evolutionary mechanisms, and establish the potential for refuges to mitigate impacts on vulnerable species. Using an extensive existing database and combined expertise, results will allow us to better predict the consequences of climate change on tropical biodiversity. This project will assist in modifying species-specific management / conservation plans for biodiversity in the Wet Tropics and developing options to mitigate threats to species at high risk of extinction, and to avoid costly management actions on species that have the necessary natural adaptive capacity.

It will also provide information to modify management practices by assessing the current ecological status and trends in biodiversity in North Queensland; the condition and trends of threatened species and communities and ultimately develop options to mitigate the threat of climate change to the Wet Tropics as a whole. In particular, the conservation of existing or addition of artificial thermally buffered habitats.

This project has many links with other MTSRF programs and projects that will be mapped explicitly in the next year. While the tourism industry's and aboriginal groups' needs were not specifically identified in the original development of this project within MTSRF, the project will now engage these stakeholders as much as possible through operational committee's and through discussion with the Tropical Tourism Alliance and Aboriginal Rainforest Council.

Key Objectives:

Extinction vulnerability

(a) To assess the relative extinction proneness and vulnerability of all rainforest vertebrate species to predicted climate changes including physiological tolerances and potential ecological responses that buffer the species from impacts.

Resilience, ecological responses, plasticity, refugia (topographic, micro-habitat)

(b) To quantify patterns of distribution and abundance of selected faunal groups, and existing levels of niche breadth and ecological plasticity with respect to climatic variables, habitat type, topography, life history traits and ecology.

(c) To identify geographic areas that potentially provide thermally-buffered habitats and measure the actual degree of microclimatic buffering across the main environmental gradients within identified refugia, replicated both temporally and spatially.

(d) To produce regional GIS coverages of microclimate based on regional climatic layers calibrated by empirical microclimate data, and to use these higher-resolution, targeted data to improve predictive spatial models of species distributions and impact predictions.

(e) To obtain empirical measurements of net primary productivity across altitudinal / latitudinal gradients within the Wet Tropics region to test hypotheses that increasing primary productivity may alleviate impacts on biodiversity.

(f) To assess the relative vulnerability of biodiversity to climate change and thereby provide management and policy recommendations on adaptation to climate change impacts and provide the knowledge to maximise the efficient utilisation of management resources across species and geographic areas.

Physiological tolerances of threatened species (arboreal mammals, microhylid frogs)

(g) To determine the physiological range and tolerances, and potential for adaptation, of those species predicted to be most at risk under climatic changes.

Project / Task Methodology

Extinction vulnerability

Objective (a): Desktop analysis of ecological characteristics of vertebrates using existing data, and spatial modelling of species distributions and biodiversity patterns that includes habitat, climate, ecological characteristics, physiology, microclimate / microhabitat relationships (Links with CSIRO 'Status and Trends' theme and 'Climate Change Project 3 Impacts on Ecosystem Processes and other Objectives in this project). Spatial modelling of fauna distributions and abundance, refugial potential and vulnerable geographic areas, employing empirically derived data (linking to Theme 1 project Status and Trends, Threatened Species and Communities, and Invasives) and in collaboration with spatial analyst (JCU CTBCC-funded).

Resilience, ecological responses, plasticity, refugia (topographic, micro-habitat)

Objective (b): Collection of faunal data using standardised survey techniques across altitudinal and latitudinal gradients in the region (mostly at existing sites). Species distribution modelling both regionally and across gradients associated with potential refugia. Use ecological characteristics and spatial analyses to measure environmental niche breadth and ecological adaptability (post-doctoral fellow funded by this projects MTSRF funds). Links to monitoring design projects in Theme 1. Linking with Theme 1 project Status and Trends, Threatened Species and Communities, and Invasives, in-kind contributions from Earthwatch and CTBCC and within this project to Objective (c).

Objective (c): Identify and collect microclimate data in potential refugia (as above) to empirically measure buffering effect; using multi-channel data loggers to measure temperature, soil moisture and humidity. Linking with Theme 1 project Status and Trends, Threatened Species and Communities and Project 2.5ii.3.

Objective (d): By calibrating regional climate layers with field based microclimate data obtained from dataloggers we can produce regional microclimate layers that will vastly improve our understanding of spatial refugia and predictive modelling of impacts. The data collection requires establishing data loggers across altitudinal and latitudinal gradients in the region. These dataloggers will be downloaded at approximately 3 monthly intervals. Additional temperature dataloggers will be placed at the same sites in a variety of microhabitats including under logs, under leaflitter, in tree hollows, in sunspots/clearings. The field assistant will be vital to managing and collecting this data as it is very time consuming and includes a lot of travel across the whole region.

Objective (e): Employ leaf litter traps, dendrometer bands and vegetation structure proforma (including hemispherical photography) at all the standard sites mentioned above. Plant inventory (to be conducted by CSIRO via links within Theme 1 Status and Trends and Project 3 Understanding the Climate Change Threat to Ecosystems and Ecosystem Processes. This subproject requires significant collaboration with the CSIRO-based Status and Trends program and Project 2.5ii.3 in this program as no funding from this project is

allocated for this subproject. Student support is already being funded via the Centre for Tropical Biodiversity and Climate Change and Earthwatch in-kind.

Objective (f): Based on findings of research provide management and policy recommendations on adaptation to climate change impacts and provide the knowledge to maximise the efficient utilisation of management resources across species and geographic areas.

Physiological tolerances of threatened species (arboreal mammals, microhylid frogs)

Objective (g): Field and lab determination of actual and potential temperature ranges of Wet Tropics microhylid frogs and arboreal mammals.

Project Targeted Activities 2009/10

Objective	Targeted Activity	Completion Date
(a)	Production of detailed assessment of extinction risk due to predicted climate change scenarios in Wet Tropics vertebrates based on ecological characteristics (linking to Theme 1 project Status and Trends, Threatened Species and Communities, and Invasives). (CTBCC in-kind)	June 2010
(b)-(f)	Determination of ecological plasticity in Wet Tropics vertebrates with regard to potential for adaptation to climatic changes Identification of the potential for refugia such as boulder fields, logs and gorges to provide areas of thermal buffering to protect species at risk from extreme temperatures. Identification of the use of these refugia by vertebrate taxa. Production of regional maps of refugial potential. (MTSRF funded Post-doc, this project) Production of GIS maps of Wet Tropics including microclimate data and spatial models of species distributions to predict impact of climate change (in conjunction with CTBCC-funded Spatial Analyst). Field work: – *Collection of faunal data using standardised survey techniques across altitudinal and latitudinal gradients in the region.* – *Identify and collect microclimate data in potential refugia (as above) to empirically measure buffering effect; using multi-channel data loggers to measure temperature, soil moisture and humidity.* – *Establish data loggers across altitudinal and latitudinal gradients in the region. These dataloggers will be downloaded at approximately monthly intervals. Additional temperature dataloggers will be placed at the same sites in a variety of microhabitats including under logs, under leaflitter, in tree hollows, in sunspots/clearings.* – *Employ leaf litter traps, dendrometer bands and vegetation structure proforma (including hemispherical photography) to estimate net primary productivity.*	June 2010
(g)	Field and lab determination of actual and potential temperature ranges of Wet Tropics microhylid frogs and arboreal mammals. (34% this MTSRF project; 66% Threatened species program)	June 2010

Project 2.5ii.4 Milestones 2009/10

For 2009/10 outputs only	Date	MTSRF	JCU
Milestones – All JCU responsibilities		**JCU**	**JCU**
Signing of contract		$30,000	$20,000^
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10		
Report 1 submission: • Current species distribution maps for rainforest fauna finalized and provided to eAtlas, coordinator of status and trends (MTSRF Project 1.2.1) and Wet Tropics Management Authority (Obj. b) • Current maps of spatial patterns of biodiversity finalized and provided to eAtlas, coordinator of status and trends (MTSRF Project 1.2.1) and Wet Tropics Management Authority (Obj. b) • Completion of case study testing the ability of species distribution models calibrated in the Wet Tropics to predict suitable environments further north on Cape York Peninsula (Obj. b, f) • Progress and status report on predictive impact modeling of climate change on rainforest fauna (Obj. f) • Preliminary results on physiological tolerances of microhylid frogs (Obj. g) • Report on physiological tolerances of arboreal mammals (Obj. g)	6 Nov 2009	$45,000	
Verbal Progress Report to Operations Committee on: • Report to update progress and general progress associated with objectives a-g (above) • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable.	Mar 2010	$32,000	
Report 2 submission: • Summary of communication activities undertaken through the course of year 4 of project. • Final reports on Objectives a-g (repeated below) with attribution of MTSRF funding: ***Extinction vulnerability*** (a) To assess the relative extinction proneness and vulnerability of all vertebrate species to predicted climate changes including physiological tolerances and potential ecological responses that buffer the species from impacts ***Resilience, ecological responses, plasticity, refugia (topographic, micro-habitat)*** (b) To quantify patterns of distribution and abundance of selected faunal groups, and existing levels of niche breadth and ecological plasticity with respect to climatic variables, habitat type, topography, life history traits and ecology. (c) To identify geographic areas that potentially provide thermally-buffered habitats and measure the actual degrees of microhabitat buffering across the main environmental gradients within identified refugia,	4 Jun 2010	$40,000	

For 2009/10 outputs only	Date	MTSRF	JCU
Milestones – All JCU responsibilities		**JCU**	**JCU**
replicated both temporally and spatially (d) To produce regional GIS coverages of microclimate based on regional climatic layers calibrated by empirical microclimate data, and to use this higher-resolution, targeted data to improve predictive spatial models of species distributions and impact predictions. (e) To obtain empirical measurements of net primary productivity across altitudinal / latitudinal gradients within the Wet Tropics region to test hypotheses that increasing primary productivity may alleviate impacts on biodiversity. (f) To assess the relative vulnerability of biodiversity to climate change and thereby provide management and policy recommendations on adaptation to climate change impacts and provide the knowledge to maximize the efficient utilization of management resources across species and geographic areas. ***Physiological tolerances of threatened species (arboreal mammals, microhylid frogs)*** (g) To determine the physiological range and tolerances, and potential for adaptation, of those species predicted to be most at risk under climate change. • Comment on future extensions for research completed under MTSRF Project 2 5ii 4.			
Total MTSRF Funding*		**$147,000**	**$20,000^**

^ JCU Cash contribution of $20,000 is to be directed towards the PhD Student Stipend

Project 2.5ii.4 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF (Obj. a,b,c,f,g)	$147,000	-	$147,000
MTSRF Visual Documentation*	$3,000	-	$3,000
JCU	$20,000	-	$20,000
JCU – Centre for Tropical Biodiversity and Climate Change (Obj. a,b,c,d,e,f,g)	-	$425,000	$425,000
JCU – Earthwatch (Obj. b,e)	-	$40,000	$40,000
JCU – Queensland Government Smart State Funds (Obj. a,b,c,d,e,f,g via Williams' salary)	-	$100,000	$100,000
WTMA (Obj. a, f)	-	$20,000	$20,000
Total	$**170,000**	$**585,000**	$**755,000**

* A total of $3,000 is held by RRRC for Visual Documentation for this project (see Theme 5).

JCU Project 2.5ii.4 Budget 2009/10

Item	MTSRF Funds	JCU Cash	JCU In-kind*	JCU In-kind**	JCU In-kind***	WTMA In-kind	Total
Salaries	$87,000	$20,000	$360,000	-	$100,000	$20,000	$587,000
Operating	$30,000	-	$30,000	$40,000	-	-	$100,000
Scholarships	$25,000	-	-	-	-	-	$25000
Travel	$5,000	-	$10,000	-	-	-	$15,000
Communication / Extension	-	-	$10,000	-	-	-	$10,000
Capital	-	-	$15,000	-	-	-	$15,000
Institutional overheads	-	-	-	-	-	-	-
Total	$147,000	$20,000	$425,000	$40,000	$100,000	$20,000	$752,000

* In-kind contribution from JCU Centre for Tropical Biodiversity and Climate Change.

** In-kind contribution from Earthwatch via JCU.

*** In-kind contribution from Smart State Fund via JCU.

PROGRAM 6
UNDERSTANDING THREATS AND IMPACTS OF INVASIVE PESTS ON ECOSYSTEMS

Program 6 is divided into two components: Invasive pests in the Great Barrier Reef (Project 2.6.1), and Invasive pests in Wet Tropics rainforests and adjoining catchments (Project 2.6.2).

Budget Summary

	Cash	In-kind	Total
MTSRF	$250,000	-	$250,000
Other	-	$252,551	$252,551
Total	**$250,000**	**$252,551**	**$502,551**

UNDERSTANDING THREATS AND IMPACTS OF INVASIVE PESTS IN THE GREAT BARRIER REEF (PROJECT 2.6.1)

Project Leader and Host Organisation

Dr David Blair, James Cook University (JCU)

The Great Barrier Reef (GBR) is a multiple use marine park where shipping, coastal development and an expanding aquaculture industry present potential risks to local biodiversity through the import of invasive species (e.g. Asian green mussel) and/or aquatic pollution.

This Program will report on the current and potential risks of invasive marine toxic dinoflagellate species in the GBR. This project will also contribute to the development of capacity in this important area of research through the conduct of a doctoral project at James Cook University.

Projects

2.6.1 Understanding threats and impacts of invasive pests in the Great Barrier Reef.....$50,000

IDENTIFICATION AND IMPACT OF INVASIVE PESTS IN THE WET TROPICS RAINFORESTS (PROJECT 2.6.2)

Project Leader and Host Organisation

Dr David Westcott, CSIRO

New or imminent incursions of invasive terrestrial pests require immediate management action without the luxury of data collection in the field. First responses to incursions are crucial yet are most effective if based on some knowledge of the invading species, in particular knowing how fast and how far an invasive can spread is fundamental to first response as it can set search areas and locations of risk.

This program will build on and refine a rapid response strategy to incursion by detailing ecological dispersal traits (e.g. introduction history, distribution, abundance, taxonomy, population parameters, reproduction, environmental tolerances, habitat preferences, movement, feeding habits), and a statement of current or potential impact of native and exotic species. These functional classifications of traits that influence the invasive spread potential of pre-emergent or new invasives will allow for data-based predictions of likely dispersal characteristics to be developed. This will be done for vertebrate-dispersed plants and fish. Gaps in knowledge of invasives have been identified in previous years which will now be used to guide research in the current and future years. The resulting classifications of invasives will allow managers to assign pre-emergent or new species to risk categories based on the spread characteristics of similar species already in Australia and to develop management response strategies based on these classifications.

To enable the program to build on current invasive research the Program will:

1. Continue to focus on species identified of key concern in workshops and stakeholder assessment. Detailed surveys appropriate to the taxa will be broadened in a regional context and will be used to build on data detailing distribution. At a species level, functional classification of invasive plants that includes dispersal, recruitment niche and life history will be completed at both a species level and at a community and landscape level. This will assist in identification of invasive 'hotspots' and of critical landscape features for invasive spread within landscapes.
2. Test and refine isotropic models of population spread through rainforest landscapes to allow assessment of the potential outcomes of management effort. Understanding how invasives move through landscapes enables prediction of patterns and rates of invasion and the opportunity to target management investment at times or in places where it will be most effective. This sub-project will i) test the process-based framework for predicting the pattern and rate of invasive spread and will use this model to ii) produce and test modelling tools that will enable prediction of invasions in real landscapes and the assessment of alternative management options.

This program is closely linked to Program 2 Status and Trends of Biodiversity and Ecosystem Services, Threatened Species and Communities projects and the Climate Change Impacts Program with the terrestrial invasives data coming from the biodiversity surveys being conducted as part of these projects. To document the landscape features that influence biological invasions of rainforest landscapes, the Program will continue to utilise GIS modelling to overlay distribution of invasives in, and landscape features of rainforest landscapes, e.g. roadsides, fragments etc. These data sets will be integrated into the e-Atlas which will enable managers and industry to access spatially explicit information on the status and trends of the Wet Tropics through a single data repository.

Projects

2.6.2 Identification and impact of invasive pests in the Wet Tropics rainforests $200,000

UNDERSTANDING THREATS AND IMPACTS OF INVASIVE PESTS IN THE GREAT BARRIER REEF (PROJECT 2.6.1)

Project 2.6.1: Understanding threats and impacts of invasive pests on the Great Barrier Reef

Project Leader and Host Organisation

Dr David Blair, James Cook University (JCU)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Dr David Blair	JCU	Objectives a, b and c, in particular the molecular aspects of the study	0.15
Dr Kirsten Heimann	JCU	Objectives a, b and c toxic microalgal culture and identification, cellular and molecular biological techniques	0.2
Paolo Momigliano	JCU	Molecular technical assistance	0.5

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	James Monkavitch
QPIF	Malcolm Dunning
Biosecurity Queensland	TBA
WWF	Cassandra Brooke, Nick Heath

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

In order to adequately protect the biodiversity of the Great Barrier Reef (GBR), there is an urgent need to determine the presence of pest species within marine and adjacent coastal habitats of the GBR region and the magnitude of the threat they pose. This will assist in the development of appropriate detection, eradication, monitoring and management strategies for research users including the Great Barrier Reef Marine Park Authority and Biosecurity Queensland. This project addresses one group of marine pests of potential concern in the GBR: toxic microalgae.

Key Objectives:

a) Develop monitoring techniques (molecular probes) to detect, identify and quantify abundance of endemic and invasive toxic microalgae;
b) Assess the magnitude of seasonal variation in abundance of toxic microalgae in parts of the GBR Province (Magnetic Island, Orpheus Island and nearby reefs); and

c) Assess public awareness of the threat posed by ciguatera poisoning, the current impact of ciguatera on regional communities and potential correlations between the incidence of poisoning and season, location (i.e. hotspots) or fish species.

Project / Task Methodology

Objective (a): Development of monitoring techniques (molecular probes) to detect, identify and quantify abundance of endemic and invasive toxic microalgae

Target species of toxic microalgae will be cultured and subjected to morphological and molecular characterisation, which will assist the development of genetic probes for identification and quantification of toxic microalgal abundance in field samples. This research will aid stakeholders to develop appropriate management and educational responses to species of concern, e.g. ciguatera risk assessment for the region.

Objective (b): Assessment of the magnitude of seasonal variation in abundance of toxic microalgae

In August 2009, macroalgal samples will be collected from Keeper, Lodestone, Ribb, Brewer, Bramble and Trunk Reefs as well as Pelorus Island, which were previously sampled in November 2008 and March 2009. Benthic toxic dinoflagellates are found on macroalgal surfaces up to about 10 m depth. Macroalgal samples are collected at 0-2 m by snorkellers and 2-10 m by divers. Fifteen macroalgal samples will be collected in separate bags on SCUBA (back reefs) and snorkelling (reef top) at each site with two sites visited each trip. Macroalgal samples will be processed to collect their associated toxic dinoflagellates within 24 hours after returning to Orpheus Island Research Station (OIRS) by shaking the samples in filtered seawater to wash off the epiphytic toxic dinoflagellates. Macroalgal samples not processed directly on return will be kept out of direct sunlight in collection bags in a tank with flow-through seawater to keep them at ambient temperature. Macroalgal samples will be photographed and portions of processed macroalgal samples will be frozen and dried on silica gel for genetic analysis and representative portions will be mounted on card board as herbarium specimens. The dinoflagellate samples will be concentrated through 20 µm nylon mesh filters and dinoflagellate concentrates will be fixed in 3.7% paraformaldehyde in filtered seawater (final concentration). Identification of toxic dinoflagellate species and their abundances will be analysed using the fixed samples on return to James Cook University, Townsville by high resolution light microscopy and scanning electron microscopy. Live samples of toxic dinoflagellates will be transported back to NQAIF at JCU to expand the toxic dinoflagellate culture collection for molecular probe development.

The development of a comprehensive atlas of toxic benthic dinoflagellates and macroalgal substrates was initiated with the data collected on the previous two field trips and will be expanded with data that will be collected in August 2009. The collection trip in August 2009 is essential to document seasonal distribution and abundance patterns.

Objective (c): Assess public awareness of the threat posed by ciguatera poisoning, the current impact of ciguatera on regional communities and potential correlations between the incidence of poisoning and season, location or fish species.

General Public and Commercial Fisheries Surveys: The general public survey will be administered over the telephone as this is the most cost-effective and efficient approach. The general public survey will require the assistance of 10 research workers to conduct the telephone surveys, as volunteer-based approaches were regarded as unreliable.

The general public survey will cover three coastal regions within the predicted distribution range of ciguateric fish, namely the Far North, Northern and Mackay regions. The combined population of these regions is 617,100 people reported on the Australian Bureau of Statistics

website for 2006 and accessed on 9 January 2009. Depending on funding, the aim is to survey 4000 people (1,590 in the Far North, 1,367 in the northern, and 1,043 people in the Mackay region), which represents 0.65% of the population in each of these regions.

Based on prior experience, it is expected that one out of four or five successful telephone calls is likely to reach a recreational fisher, resulting in the potential survey of 800-1,000 recreational fishermen.

The survey will include pre-screening questions to establish whether respondents eat locally-caught fish or not, as those who do not are at no risk of ciguatera. A tally of these respondents will be kept, as well as a tally of those who eat local fish but did not contract ciguatera. The 4,000 regional inhabitant surveys will collate information provided by ciguatera-positive people. While this increases the sample size, it is not expected to increase survey costs, as no-risk inhabitants and ciguatera-negative surveys will not require the same commitment of time. Other pre-screening questions will determine if respondents buy their fish at local shops or consume self-caught fish, as well as how often they eat fish. Implementation of the survey in this manner extends the potential of the survey to calculate true incidence of ciguatera poisoning in the region and will allow the allocation of respondents into risk levels (high, medium, low, no risk).

Information on commercial fishers moored and operating in the region will be sourced from the Port Authorities in Mackay, Townsville, and Cairns. Those that specialise in catching of reef fish will be selected and asked to provide information contained in the commercial fisheries ciguatera questionnaire. These telephone surveys will be conducted by Leanne Sparrow, Associate Professor Kirsten Heimann, and Professor David Blair.

Indigenous people / Elder Surveys: Surveys of Indigenous communities and Elders for the Eastern Torres Strait Island and Northern Great Barrier Reef region will be carried out on a volunteer basis by David Seekee, while surveys of Indigenous communities and their Elders in the Cape York region will be tied in with work planned by GBRMPA, pending approval by GBRMPA. Surveys in the Innisfail to Bloomfield/Daintree region will be carried out by a volunteer from the School of Indigenous Australian Study from the Cairns Campus of James Cook University, the Ayr to Mission Beach region by Leanne Sparrow, who attended two Indigenous People workshops, Associate Professor Kirsten Heimann and Professor David Blair, and the Mackay area up to Cape Upstart by a volunteer from the School of Indigenous Australian studies from the Mackay Campus of James Cook University.

All surveys administered to Indigenous communities will be advertised by poster in the respective Indigenous communities 4 weeks prior to conducting the surveys. In addition, all visits to Indigenous communities will be carried out in the presence of an independent mentor. A search for a suitable person has commenced.

Project Outputs/Outcomes

Objective (a): Development of monitoring techniques (molecular probes) to detect, identify and quantify abundance of endemic and invasive toxic microalgae

The development of molecular probes and the assessment of the extent of seasonal abundance patterns of toxic microalgae will enable risk assessment of the potential of seafood poisonings and ciguatera to communities along the GBR.

Objective (b): Assessment of the magnitude of seasonal variation in abundance of toxic microalgae

The collection trip in August 2009 is essential to document seasonal distribution and abundance patterns. The toxic dinoflagellate and macroalgal substrate atlas will be published

in colour through the Reef to Rainforest Research Centre and the Great Barrier Reef Marine Park Authority and will be essential to assist authorities in future species identification of toxic microalgae and their macroalgal substrates.

Objective (c): Assess public awareness of the threat posed by ciguatera poisoning, the current impact of ciguatera on regional communities and potential correlations between the incidence of poisoning and season, location or fish species

The ciguatera questionnaires targeted at the general public/recreational fishers and commercial fishers will provide information to fill specific knowledge gaps concerning the incidence and seasonality of ciguatera poisoning, high-risk fish species and hot-spots for ciguatera poisoning within the North Queensland region. The ciguatera questionnaire targeted at Indigenous communities and Indigenous Elders will explore traditional owner knowledge of ciguatera and enable to investigate the relationship between the historical incidence and distribution of ciguatera poisoning and other environmental changes associated with land-use or climate to be examined. The outcomes of these surveys will enable the real economic and health impacts on the region to be assessed and appropriate and effective risk-assessment and management tools to be developed, If the surveys can be conducted at the scale planned, which is dependent on additional funding. The community at large will be better informed of the current and likely future risks, with specific knowledge of seasonal variation of ciguatera producing microalgae and high-risk hot-spots and fish species.

All three objectives will provide the opportunity to develop educational materials, including the development of a toxic microalgae GBR identification guide, to inform the general public of potential higher risk seasons, locations and fish species.

Project Milestones 2009/10

Targeted Activity	Completion Date
Continued development of molecular probes to: (i) extend capacity to recognize an ever greater range of species; and (ii) improve sensitivity and specificity.	June 2010
National and, where appropriate, international conference presentations on aspects of each task	June 2010
Seasonal field work to identify seasonal trends in abundance of toxic microalgae	June 2010
Administration of questionnaires enquiring into public knowledge of ciguatera poisoning, its incidence, causes, regional hot-spots and seasonality. The delivery of this activity is dependent on additional funding, as the current budget does not allow for conducting the surveys at the planned scale.	June 2010
Continued development of the Atlas of Marine Microalgae in the GBR	June 2010

Project 2.6.1 Milestones 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**JCU**
Signing of contract		$16,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
• Interim Report (with appropriate attribution of MTSRF funding) on seasonal sampling of toxic microalgae from the central GBR.	13 November 2009	$8,000
• Final report (with appropriate attribution of MTSRF funding) on culture of microalgae and identification of species thus represented.	15 February 2010	$8,000
• Final report (with appropriate attribution of MTSRF funding) on development of molecular probes. • Final report (with appropriate attribution of MTSRF funding) on seasonal sampling of toxic microalgae from the central GBR. • Final report (with appropriate attribution of MTSRF funding) on results from questionnaires administered to stakeholder groups. The delivery of this milestone is dependent on additional funding, as the current budget does not allow conducting these surveys at the planned scale. • Delivery of spatial information included in the Atlas of marine microalgae to the e-Atlas (MTSRF Project 1.1.5). • Final summary of communication activities (e.g. any presentations/seminars) undertaken through the course of Year 4. • Meta-data describing all data generated by MTSRF Project 2.6.1 lodged on the e-Atlas.	1 June 2010	$16,000
Total MTSRF Funding		**$48,000**

* Total excludes money held for Visual Documentation.

Project 2.6.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$48,000	-	$48,000
MTSRF Visual Documentation*	$2,000	-	$2,000
JCU	-	$52,551	$52,551
Total	**$50,000**	**$52,551**	**$102,551**

* A total of $2000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

JCU Project 2.6.1 Budget 2009/10

Item	MTSRF	JCU – In Kind	Total Cost
Salaries	$25,000	$52,551	$77,551
Operating	$20,000	-	$20,000
Travel	$3,000	-	$3,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$48,000**	**$52,551**	**$100,551**

IDENTIFICATION AND IMPACT OF INVASIVE PESTS IN THE WET TROPICS RAINFORESTS (PROJECT 2.6.2)

Project 2.6.2: Identification and impact of invasive pests in the Wet Tropics rainforests

Project Leader and Host Organisation

Dr David Westcott, CSIRO

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
David Westcott	CSIRO	Tropical Vertebrate Ecologist	0.30
Dan Metcalfe	CSIRO	Tropical Plant Ecologist	0.05
Denise Hardesty	CSIRO	Plant and Invasion Geneticist	0.15
Cameron Fletcher	CSIRO	Ecological Modeller	0.38
Adam McKweon	CSIRO	Ecological Technician	0.10
Suzanne Metcalfe	CSIRO	Ecological Technician	0.10
Tina Lawson	CSIRO	Ecological Technician	0.10
Dean Jones	CSIRO	Ecological Technician	0.05
Scott Heckbert	CSIRO	Ecological Modeller	0.05
Helen Murphy	Weeds CRC / CSIRO	Invasion Biologist	0.10
Damien Burrows	ACTFR	Fish Ecologist	0.20
Allen Webb	ACTFR	Fish Ecologist	0.25
John Russell	QPIF	Fish Ecologist	0.10
Kylie Galloway	QDNRandM	Weed Eradication Manager	0.10
Simon Brooks	QDNRandM	Weeds Scientist	0.10
Rowena Grace	FNQ NRM Ltd	Terrestrial Biodiversity Program Manager	0.05
Kirby Doak‡	FNQ ROC	Liaison with Local Govt	0.02
Steve Goosem‡	WTMA	Biodiversity Planning and Policy	0.02

‡ To be confirmed.

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Steve Goosem
Terrain NRM Ltd	Allan Dale
Biosecurity Queensland	Shane Campbell
EPA	Mark Parsons
Alliance for Sustainable Tourism	Melinda Connolly

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

This project focuses on invasive species (including translocated native species) and will develop tools for predicting the spread of invasive species in rainforests and modified coastal landscapes, map the distribution and document the impacts of invasive species, identify priority species for detailed study, and carry out those detailed studies. This will include an analysis of end user needs and priorities as well as research currently being undertaken in the Weeds CRC, the Australasian Invasive Animals CRC and the Plant BioSecurity CRC, to identify exactly where MTSRF can get the best return on its investment in invasive species.

For the purposes of this project invasives are defined (from a European perspective) as species moved beyond their natural range and may include exotic, translocated, and pest species. The term "rainforest landscapes" is used to include terrestrial and aquatic systems and human-dominated parts of the landscape (agricultural and urban areas) as well as rainforest ecosystems.

Key Objectives:

(a) Assessment of research needs for management of invasives.
(b) Frameworks and tools for predicting invasive species' spread through rainforest landscapes.
(c) Distribution and impacts of invasives.
(d) Research into priorities species and those identified in Objective (a).

Project / Task Methodology

Objective (a): Assessment of research needs for management of invasives

The final year will include a reassessment of future research needs, current threats and preparedness to meet these. These activities will be conducted via a scoping workshop, literature review and interviews to ascertain threat and impact. A Reporting Workshop will contribute to finalization of the scoping study, research goal setting and identification of priority species for on-going research focus.

Objective (b): Frameworks and tools for predicting invasive species' spread through rainforest landscapes

All biological invasions, irrespective of whether they are invasions by exotic plants, animals, diseases or translocated native species, are the expression of a single process – the movement of individuals through the landscape. Understanding how invasives move through landscapes enables prediction of patterns and rates of invasion and the opportunity to target management investment at times or in places where it will be most effective. This sub-project will i) develop a process-based framework for predicting the pattern and rate of invasive spread and will use this model to ii) produce and test modelling tools that will enable prediction of invasions in real landscapes and the assessment of alternative management options. Being process, rather than species based, the modelling framework will be generalizable to a wide-range of invasive species. Currently adequate movement data exists to allow development and application with fleshy-fruited invasive plants, e.g. *Miconia calvescens* and *Annona glabra*, but the approach will be extended to other taxa, e.g. fish or deer, as appropriate and possible. Additional movement data will need to be collected for

other invasive taxa, however, the modelling framework itself will not have to be re-developed and will prescribe the data to be collected.

In the first instance, a proof of concept modelling framework will be developed, parameterised and tested in the context of fleshy fruited invasive plants, e.g. *Miconia calvescens, Annona glabra.* These have been chosen because: 1) they are high on the list of priorities identified by WTMA and Terrain NRM as high risk invasive plants; 2) they are the focus of significant current on-ground management efforts by QDNRMW and Local Government; and 3) high quality data on the movement of fleshy fruited plants within the landscape is available from the Rainforest CRC. The modelling framework will employ spatially-explicit percolation modelling, based initially on isotropic dispersal curves (symmetric dispersal in all directions).

The framework will be refined to improve predictive ability by incorporating models of disperser movement responses to landscape structure.

The majority of this data has already been produced as part of the Rainforest CRC though some additional data may need to be collected. This will be done using continuous radio-telemetry as appropriate.

Models will be tested and validated in collaboration with QDNRandM's Tropical Weeds Eradication Team and where appropriate or possible with Local Government. Dispersal predictions will be developed for real infestations and these will then be tested against the plants found in the field by the eradication teams. In addition, QDNRMW will provide spatial data on historical *M. calvescens* infestations and these will be used to post-predict the actual pattern of these invasions. *M. calvescens* incursions in FNQ are still in the very earliest phases of invasion; the initial incursion and establishment phases. These phases are virtually undescribed as invasions are usually not described until after the establishment phase. Consequently, it represents an opportunity to document demographic and genetic processes that influence the early success of invasions. This will be done as a comparative study of *M. calvescens* and *Melastoma affine* (a native species in the same family as *M. calvescens*, the Melastomataceae). This work will use micro-satellite markers to perform genetic parentage analysis, progeny dispersal distances, and spatial genetic structure.

New or imminent incursions require immediate management action without the luxury of data collection in the field. First responses to incursions are crucial yet are most effective if based on some knowledge of the invading species, in particular knowing how fast and how far an invasive can spread is fundamental to first response as it can set search areas and locations of risk. We will use existing data on ecological (e.g. introduction history, distribution, abundance, taxonomy, population parameters, reproduction, environmental tolerances, habitat preferences, movement, feeding habits), dispersal traits and a statement of current or potential impact of native and exotic species to develop a risk assessment of current and potential invasives. Functional classifications of traits that influence the invasive spread potential of pre-emergent or new invasives and allow for data-based predictions of likely dispersal characteristics to be developed will be done for vertebrate-dispersed plants and fish. The resulting classifications will allow managers to assign pre-emergent or new species to risk categories based on the spread characteristics of similar species already in Australia and to develop management response strategies based on these classifications. This analysis is guiding the research directions in ARP4 and in our preparation for future research.

Objective (c): Distribution and impacts of invasives

Description of the distribution of invasives within landscapes will be derived from existing data and other work. For terrestrial invasives, data will come from the biodiversity surveys being conducted as part of Program 2, Status and Trends of Biodiversity and Ecosystem Services, Threatened Species and Communities and Program 5ii, Rainforest Climate Change. These surveys document the presence and abundance of incidence of plant and avian biodiversity against landscape structure and vegetation types. Aquatic invasives data will come from the Wet Tropics Fish Atlas (Rainforest CRC), NHT Pest Fish project (ACTFR), long-term monitoring (QPIF), and additional field surveys as required. To document the landscape features that influence biological invasions of rainforest landscapes, we will use GIS modelling to overlay distribution of invasives in, and landscape features of rainforest landscapes, e.g. roadsides, fragments etc. We will compare this distribution data with landscape condition data, collected as part of the existing projects and / or GIS information from ACTFR, QPIF and CSIRO.

Focus will be on species identified as of key concern in previous assessments conducted by stakeholders, e.g. WTMA, Terrain NRM Ltd, local government etc. Detailed surveys appropriate to the taxa will be used to document distribution for selected taxa and otherwise will rely on reporting through managers. Where feasible, impact studies will be designed appropriately for the identified taxa but may include comparative studies of community structure and functioning in infested and uninfested areas, studies of direct competition between species, comparative studies of economic and other costs.

Objective (d): Research into priority species and those identified in Objective (a)

This will involve research into the population and community ecology of invasives, including their impacts and control research as identified in the scoping study. Methods will vary according to the taxa and question. In the case of aquatic invasives, to evaluate the effectiveness of control and / or removal methods, we will implement several methods based on the outcomes of (1) the identification of critical invasion processes, and (2) critical landscape condition and landscape hotspots. Exact methods will depend on the outcomes of (1) and (2), but may include riparian rehabilitation, removal of fish barriers, and removal of aquatic weeds. These methods will complement methods already being considered by existing projects (NHT Pest Fish project (ACTFR) and Tilapia population modelling (QPIF)).

Project Targeted Activities

Objective	Targeted Activity	Completion Date
CSIRO Modelling		
(b)	Incorporation of isotropic model of population spread into management model to allow assessment of the potential outcomes of management effort. Incorporates realistic, mechanistic, anisotropic models of dispersal and the impact of control on patterns of spread given these	Sept 2009
(b)	Development of an integrated, whole of system model of pig management in collaboration with Terrain NRM and managers. Identification of data and research needs	Jun 2010
(c)	Spread model refinement, application with end-users	Jun 2010
(b)	Trialling with managers complete and model ready for application	Jun 2010
CSIRO Genetics		
	Comparison of population genetic structure in native, non-Australian and Australian invasive range of *Miconia calvescens*	Dec 2009
(c)	Testing of model predictions and description of genetic factors influencing incursion and establishment phases of incursions	Dec09
(b)	Description of the role of novel processes in invasive spread through a comparison of native and invasive dispersal population parameters finalised	Jun 10
(b)	Genetic description of Melastome invasion history in Australia and its application to management	June 2010
ACTFR		
	Provide distributional data and associated environmental data as part of contribution to modelling of the environmental variables that may (i) limit or prevent spread, and (ii) contribute to or promote the spread of invasive fish	Dec 2009
(d)	Completion of assessment of dissolved oxygen tolerances of pest fish. *Provide regional scale data across the Wet Tropics region to input into region-wide assessment of environmental predictor variables (fish atlas data from ACTFR)*	Jun 2010
DEEDI/ Terrain		
(c)		June 2009
	Broaden spatial model to include regional survey data from fish atlas (ACTFR), as well as spatial data layers on additional environmental variables that may affect invasive fish spread at Wet Tropics regional scale	Dec 2009
	Prediction of presence, abundance and locations for control of invasive fish	Dec 2009
(c)	Final classification of landscape features influencing invasion in rainforest landscapes	Jun 2010

Project 2.6.2 Milestones 2009/10

For 2009/10 outputs only	Date	MTSRF	MTSRF	MTSRF
Milestones [responsible agency listed in square brackets]		**CSIRO**	**JCU**	**DEEDI (QPIF)**
Signing of contract/Attendance at Operations Committee meetings (3 per year).		$58,500	$3,750	$7,500
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-
Verbal Progress Update to Operations Committee: • Communication plan for final year and summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable. [CSIRO with contributions from all] Final written reports on: • Report on isotropic model of seed dispersal and its application to management (CSIRO) • Publications outlining MTSRF/BioSecurity Queensland collaborative research presented at the International Miconia Workshop in Hawaii. (CSIRO) with attribution of MTSRF funding.	Nov 2009			
Final report: • Genetic description of Melastome dispersal at local and regional scales (CSIRO) with attributionof MTSRF funding. • Refer to deliverables specified in ARP3	Feb 2010	$58,500		
Report 3 submission: • Final Report comparing population genetic structure of *Miconia* invasions across the Pacific (CSIRO) • Final Report on environmental variables limiting or contributing to the spread of invasive fish (CSIRO/DEEDI/ACTFR) • Final Report on the dissolved oxygen tolerances of pest fish (ACTFR) • Final Report on spatial strategies for control of invasive plants (CSIRO). • All reports/products to have attribution of MTSRF funding.	May 2010	$58,500	$3,750	$7,500
Total MTSRF Funding		**$175,500**	**$7,500**	**$15,000**

Project 2.6.2 Budget 2009/10

Contributing Organisation	Cash	In-kind	Total
MTSRF	$198,000	-	$198,000
MTSRF Visual Documentation*	$2,000	-	$2,000
CSIRO	-	$175,712	$175,712
JCU	-	$7,500	$7,500
QPIF	-	$15,000	$15,000
FNQ NRM Ltd	-	-	-
Total	**$200,000**	**$198,212**	**$398,212**

CSIRO Project 2.6.2 Budget 2009/10

Item	MTSRF Funds	CSIRO In-kind	Total Cost
Salaries	$133,000	$26,649	$159,649
Operating	$30,000	-	$30,000
Travel	$12,500	-	$12,500
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$148,563	$148,563
Total	**$175,500**	**$172,512**	**$350,212**

JCU Project 2.6.2 Budgtet 2009/10

Item	MTSRF Funds	JCU In-kind	Total Cost
Salaries	$6,500	$7,500	$6,500
Operating	$1,000	-	$1,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	$7,500
Total	**$7,500**	**$7,500**	**$15,000**

DEED (QPIF) Project 2.6.2 Budget 2009/10

Item	MTSRF Funds	QPIF In-kind	Total Cost
Salaries	$12,000	$15,000	$27,000
Operating	$1,500	-	$1,500
Travel	$1,500	-	$1,500
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$15,000**	**$15,000**	**$30,000**

THEME 3
HALTING AND REVERSING THE DECLINE OF WATER QUALITY

Water quality is a key issue for North Queensland's environmental assets. Water quality is vital to the ongoing health of the Great Barrier Reef and the rainforest, and for the communities, industries and ecosystems that rely on good water quality in North Queensland's catchments. Research conducted will provide information for halting the decline of water quality entering the Great Barrier Reef lagoon by considering influences across catchments. The research conducted as part of this program will provide valuable information to assist the evaluation of the Reef Rescue Plan.

Theme 3 Budget Summary

Program	Title	MTSRF	Other Cash	In-kind	TotaL
Program 7	Water Quality	$1,175,000	-	$1,702,632	$2,877,632
Total		**$1,175,000**	**-**	**$1,702,632***	**$2,877,632**

** In-kind contributions still to be confirmed.

The total value of Theme 3 is $2,877,632.

PROGRAM 7
HALTING AND REVERSING THE DECLINE OF WATER QUALITY

Program Leaders and Host Organisations

Dr Katharina Fabricius, Australian Institute of Marine Science (AIMS)
Professor Richard Pearson, James Cook University (JCU)
Professor Iain Gordon, CSIRO

Program 7 Budget Summary

	Cash	In-kind	Total
MTSRF	$1,175,000	-	$1,175,000
Other	-	$1,702,632	$1,702,632
Total	**$1,175,000**	**$1,702,632**	**$2,877,632**

* In-kind contributions still to be confirmed.

The quality of water entering the Great Barrier Reef (GBR) lagoon has been declining and is negatively affecting the condition of GBR ecosystems. There is urgent need to increase certainty about the effectiveness of actions taken under the Reef Water Quality Protection Plan (Reef Plan) and those to be taken under the Reef Rescue Plan, as well as for improved scientific understanding of how the condition of freshwater, estuarine and marine ecosystems are linked to terrestrial processes. The Water Quality Program consists of three main areas:

- Marine and estuarine water quality;
- Freshwater water quality; and
- Economic and social frameworks for water quality.

The main outcome of this Program is to further identify robust indicators for water quality in freshwater, estuarine and marine ecosystems which will enable the development of tools to improve water quality specific monitoring and determine pollutant thresholds of potential concern for exposure of key ecosystems to sedimentation, light, nutrients and herbicides. The program will also develop improved approaches for the estimation of end of river loads and guidance on the appropriate mechanism by which the load of pollutants entering the Reef can be estimated. The approach will be tested for use in identifying priorities for the Reef Rescue Plan.

The program will also develop catchment-specific tracers for improved understanding of the links between terrestrial and marine water quality, and for identification of GBR lagoon areas at greatest risk of exposure to land-based pollutants. The tracer project will characterise and obtain a distinct isotopic, elemental, physical and mineralogical “fingerprint” of the fine sediments (mud fraction) delivered to GBR within selected Wet Tropics and Dry Tropics catchments.

In addition the program will further develop predictive tools to enable the impacts of changes in land use, management and climate on the flow and water quality regimes and ecological dynamics in the wetlands and floodplains of catchments adjacent to the GBR. There is a considerable gap in our current understanding of ecological connectivity between coastal wetlands and Reef and the impact declining water quality has on this important linkage.

Two projects conducted as independent processes in year one was brought together in year two to strengthen the delivery and outcomes for end user needs regarding social and economic considerations for improving water quality in the GBR. The amalgamation of these critical research components has resulted in greater benefit from work conducted by enabling stronger linkages between catchment based activities, water quality and climate to be established. The third year of the program will explore sustainable environmental targets and associated land use and land management patterns in linked terrestrial and marine ecosystems in the Dry Tropics. This will include the assessment of instruments promoting the adoption of land use and land management patterns.

The e-atlas will provide a mechanism by which data collated through this program can be assimilated with other data sources and interpreted for relevant management and reporting needs for water quality in the Great Barrier Reef.

Projects

3.7.1	Marine and estuarine indicators and thresholds of concern	$300,000
3.7.2	Connectivity and risk: tracing materials from the upper catchment to the reef	$275,000
3.7.3	Freshwater indicators and thresholds of concern	$175,000
3.7.4	Wetlands and floodplains: connectivity and hydro-ecological function	$175,000
3.7.5	Socio-economic constraints to and incentives for the adoption of land use and management options for water quality improvement	$150,000
3.7.6	(This project has been amalgamated with Project 3.7.5 and activities and funding for this project now sit under that project heading)	Nil
3.7.7	Analysis and synthesis of information for reporting credible estimates of loads for compliance against targets and tracking trends in loads.	$100,000

PROGRAM 7: HALTING AND REVERSING THE DELINE OF WATER QUALITY

Project 3.7.1: Marine and estuarine indicators and thresholds of concern

Project Leader and Host Organisation

Dr Katharina Fabricius, Australian Institute of Marine Science (AIMS)

Project Team 2009/10

Title	Organisation	Role	FTE
Katharina Fabricius	AIMS	Program leader, Researcher, coral reef	0.3
Sven Uthicke	AIMS	Researcher, biofilms	0.8
Craig Humphrey	AIMS	Researcher, biomarkers and ecology, support	0.5
Andrew Negri	AIMS	Researcher, biomarkers, ecotoxicology	0.1
Miriam Weber	AIMS	Visiting Postdoc, microsensors	0.2
Joost van Dam	AIMS/UQ	PhD Student, biofilms	1.0
Verena Witt	AIMS	PhD Student, biofilms	1.0
Marcus Sheaves	JCU	Researcher, estuaries	0.1
Rod Connolly	GU	Researcher, estuaries	0.1
Len McKenzie	QPIF (DEEDI)	Researcher, seagrasses	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Hugh Yorkston, Laurence McCook, Donna Audas
DEWHA	Kevin Gale, Olga Braga
Alliance for Sustainable Tourism	Annie Riddet
Queensland Premiers Department	Claire Anderson
Terrain NRM	Allan Dale
Reef Check Australia	Marie-Lise Schlappy
EPA	David Scheltinga, Andrew Moss
WWF	Nick Heath
FBA	Nathan Johnson
BDTNRM	Diana O'Donnell, Rachel Allan
Reef Catchments Mackay Whitsunday	Carl Mitchell
Dupont	Joe Dulka
Oceanwatch	Carla Wegscheidl
APVMA	Liesel Schiller

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This project aims at improving the understanding of the effects of terrestrial runoff on the health and condition of inshore marine and estuarine ecosystems, and to develop, test and apply a system of indicators to monitor changes in water quality and resulting ecosystem health. Years 1 to 3 were used to complete a series of field studies and reviews to prioritise potential marine and estuarine indicators, and to determine dose-response relationships and thresholds of potential concern in selected bioindicators to pollutant exposure. The research has resulted so far in 8 submissions for journal publications and 5 student theses. In Year 4 we will complete study, and develop and road-test practical methods instructions for inclusion into monitoring programs. The biofilm and coral components will complete finetuning benthic measures as WQ indicators by experimental work, and by testing the validity of the priority indicators on the Reef Rescue Marine Monitoring Program inshore study sites, validated by their environmental data. We will publish and distribute electronically, (1) an manual for non-specialists, and (2) a Standard Operational Procedures Report of how to use biofilm- and coral-based indicators to monitor inshore ecosystems exposed to changing water quality. These will be targeted at groups such as the ReefCheck groups and internationally the GCRMN groups. We will also complete our field work, analyses and identification of useful ecological indicators of the condition of North Queensland's estuaries.

The Key Objectives are to:

(a) Complete the development of a practical composite bioindicator system based on biofilms for improved monitoring of water quality and for hindcasting past water quality conditions.

(b) Complete the development of a practical composite bioindicator system based on coral reef organisms and physiological changes to indicate changes in water quality and ecosystem condition.

(c) Contribute to research on seagrass communities and their responses to changing environmental conditions along the Queensland coast.

(d) Complete the identification of useful ecological indicators of the condition of North Queensland's estuaries.

Project / Task Methodology

Objective (a): Develop an indicator system based on benthic biofilms for improved water quality monitoring in the GBR

Progress: Years 1 to 3 were used to identify and review organism groups in biofilms that consistently change along water quality gradients (bacterial biofilms on sediments, microphytobenthos layers on sediments, and foraminifera on sediment and other reef substrata). Specifically, laboratory experiments and field transplants were conducted to investigate the effects of light and nutrients on growth, mortality and photosynthesis of several foraminiferan species in the laboratory. We have also conducted field studies to identify bacterial communities specific to high nutrient/low light conditions. We have also completed the analyses of the foraminiferan samples collected by the Reef Rescue Marine Monitoring Program across 30 nearshore reefs. We also sampled and started to date long sediment cores to investigate whether changes in foraminiferan communities may be used to hindcast changes in land use in the GBR catchment over the last 200 years sediment cores. We also started to work on interactions between water quality parameters and global warming by manipulating both temperature and water quality parameters in aquarium

experiments. In addition, supported by a MTSRF funded PhD student (J. van Dam), we have started to experimentally investigate the interactive effects of pesticides and warming temperatures on 14 benthic foraminiferan species. We have published an easy to use web-based foraminiferan guide for the GBR, a major step towards facilitating the use of foraminifera in monitoring programmes. A new PhD student (V. Witt) joined in the microbial work, to continue testing bacterial biofilms as indicators for water quality. Our initial results have shown distinct differences in microbial communities in inshore and offshore waters, both in sediments and on artificial substrata, and narrowed down the focus to a subset of target groups for monitoring.

In Year 4, we will continue to closely collaborate with the Reef Rescue Marine Monitoring Program to maximise the use of the inshore monitoring data, and with the Tracers Project. We will summarise results from the foraminifera work to result in final recommendations about this group as WQ indicator. These recommendations will take into consideration results from the last round of experiments, and field monitoring that will be compared against the Reef Rescue Marine Monitoring Program data and the results of the hindcasting. All foraminifera from the deed sediment cores have already been sorted, but in year 4 we will receive results from the sediment aging of the cores. Experimental and field work will focus on the microbial indicators and experiments on isolated foraminiferan symbionts. In addition, we will analyse data on C and N content of foraminifera and provide recommendations whether these can constitute a further easy to use foraminiferan based indicator. With regards to bacteria, we will test a fast genetic fingerprinting method to identify bacteria which may potentially serve as indicators for water quality. We will also conduct manipulative experiments on biofilm bacteria to test which factors alter communities and how this altered community can effect recruitment on the reef. Further experiments will investigate interactive effects of water quality and global change on corals and foraminifera. Finally, we will develop protocols to optimize inshore monitoring programs, identify thresholds and develop and field test monitoring protocols. We will also cross-link to the Tracers Project to assess present-day and past water quality conditions based on *Porites* skeleton cores.

Objective (b): Coral indicators for ecosystem condition

Progress: Years 1 to 3 have been used to identify and review suitable indicator measures in corals and reef communities that consistently change along water quality gradients in the field at response times of days (gene expression and physiology), to weeks or months (populations responses), and years (community responses). We have determined concentration-response relationships of key species in the AIMS controlled environment aquarium facility using environmentally relevant exposures and ecotoxicological protocols. A literature review and tests of priority indicators along the Whitsundays water quality gradient resulted in 11 priority indicators being recommended for further testing in other NRM regions and laboratory validation experiments. In collaboration with the inshore Reef Rescue Marine Monitoring Program team, we then tested the consistency of a subset of the priority indicators across the four main inshore MMP regions (Fitzroy, Mackay-Whitsundays, Burdekin and Wet Tropics Regions), to relate indicator values to the MMP water quality data. We also determined chlorophyll and turbidity thresholds for coral and octocoral biodiversity and macroalgal cover in the GBR, and proposed these as WQ guideline values.

In Year 4, we will complete the research determining thresholds of potential concern and concentration-dependent responses in key indicators in controlled experiments, and we will combine the indicators to develop a composite indicator system. We will also complete a reanalysis of experimental and field data to identify chlorophyll concentrations (chronic conditions and episodic floods) that are thresholds for the development of outbreaks of crown-of-thorns starfish. Finally, we will design, test and publish an easy-to-use illustrated manual and a Standard Operational Procedures Report of how to use biofilm- and coral-based indicators to monitor inshore coral reefs exposed to changing water quality.

Objective (c): Indicators for seagrass condition in response to changing water quality

In the last year of Project 3.7.1 we plan to complete the analysis and interpretation of mapping, monitoring and experimental data from our research in MTSRF Project 1.1.3 with Projects 3.7.1 and 1.1.5, with a focus on identifying physiological, morphological, community measures and indicators of meadow resilience in response to changing water quality. This proposed research directly addresses the GBRMPA 'critical' research issue "What are the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) on seagrass beds i.e. pollutant load-impact relationships?" and "What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?".

Objective (d): Estuarine indicators for ecosystem condition

Progress: Completed major sampling program in estuarine areas with contrasting biophysical characteristics, in line with characterisation in the OzEstuaries data base as near pristine, modified and highly modified. Sampling was designed to evaluate and develop process-level indicators of ecosystem condition, in particular 1) success of nursery ground provision, 2) health of juveniles at the end of nursery ground residence, 3) spawning success, 4) food web integrity and functioning, 5) the integrity of crucial functional guilds: detritivores, benthivores, scavengers. Data analysis has been completed to the point where we have revised the indicators of estuarine health.

Standard multivariate analysis of fish communities does not provide a suitable assessment of estuarine health. This is contrary to conclusions from studies of temperate estuaries elsewhere in the world. In the estuaries of North Queensland, the fish fauna overall is distinct for each estuary, but is relatively consistent through time. Estuarine health or integrity is thus best assessed using more refined biotic measures, likely to provide sensitive, site-specific indicators of changes in estuarine health. Of those measures we have tested, the integrity of functional guilds continues to show promise. And a new measure, species composition based only on species spawning in estuaries, also appears to be a good indicator.

In Year 4, there are two main tasks. First, we will evaluate the success of our models, by application of the methods and models to a series of estuaries. Validation of our newly revised indicators will include a limited sampling program in estuaries not previously sampled but known to fall at different places along the pristine-disturbed gradient, as well as extended sampling of selected model estuaries to increase the length of time series data for those estuaries. This validation will be done early enough to permit the final validation to be included in the conclusions of the final report.

Second, we will finalise and publicize our fish metrics of estuarine health. We aim to produce a simplified rating scheme for estuaries or parts of estuaries, underpinned by robust statistical analysis of fish variables. We will also complete the development of standard operational procedures for future use by monitoring programs, and disseminate optimised monitoring methods based on novel and improved indicators for water quality and ecosystem conditions.

Project Outputs/Outcomes

For biofilm-based indicators, the work on foraminifera will be completed with some additional experiments. In addition to the already released foraminiferan identification guide we will develop Standard Operational Procedures for collection and analysis of benthic foraminifera as water quality indicators. Microbial work will continue to elucidate which bacteria can serve as potential water quality indicators and describe the ecological effects of altered microbial communities.

For coral-based indicators, further work to identify critical levels of major water pollutants, and the completion of Standard Operational Procedures to monitor novel and improved indicators for water quality and ecosystem conditions will substantially improve the capacity to manage and monitor reef health and to support the ongoing Reef Plan efforts. The publication and distribution of an easy-to-use glossy manual will also help establishing the use of biofilm- and coral-based indicators to monitor inshore ecosystems exposed to changing water quality.

For seagrasses, the analysis and interpretation of mapping, monitoring and experimental data from research in MTSRF Project 1.1.3 with Projects 3.7.1 and 1.1.5, will be completed. A final report on physiological, morphological, community measures and indicators of meadow resilience in response to changing water quality will be submitted.

Final fish metrics of estuarine health will be publicised; this will provide a simplified rating scheme for estuaries or parts of estuaries, underpinned by robust statistical analysis of fish variables. We will also develop standard operational procedures for future use by monitoring programs.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)	Complete development of marine biofilms (bacteria, diatoms, foraminifera) as indicator tools for changing water quality [AIMS]	June 2010
(b)	Complete development and establish application of coral reef organisms and physiological change to indicate changes in water quality and ecosystem condition [AIMS]	June 2010
(c)	Contribution to research on seagrass communities and their responses to changing environmental conditions along the Queensland coast [QPIF]	June 2010
(d)	Complete the identification of useful ecological indicators of the condition of North Queensland's estuaries [JCU, GU]	June 2010

Project 3.7.1 Milestone Payments 2009/10

For 2009/10 outputs only **Milestones**	Date	MTSRF AIMS	MTSRF DEEDI	MTSRF JCU	MTSRF GU
• Signing of contract		$62,000	$5,000	$10,000	$10,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-	
Report 1 submission: • Progress update for activities listed against objective (a) and (b) [AIMS] • Progress update for objective (d) (above) [JCU, GU] • Summary of any liaison activities undertaken to date. [AIMS]	15 Nov 2009	$62,000	-	-	-
Report 2 submission: • Progress update for activities listed against objectives (a) and (b) (above). [AIMS] • Complete field work for the activity listed against objective (a) and (b). [AIMS] • Progress update for objective (c) (above). [QPIF (DEEDI)] • Progress update for activities listed against objective (d) [JCU, GU]. • Summary of any liaison activities undertaken to date. [AIMS]	15 Feb 2010	$62,000	-	-	-
Report 3 submission: • Complete Final Report on the use of foraminifera and bacteria in biofilms as indicators for reef health (objective a). [AIMS] • Complete Final Report on the use of coral reef organisms and physiological change to indicate changes in water quality and ecosystem condition (b). [AIMS] • Complete manual and Standard Operational Procedures report on the use of biofilm and coral-based indicators (a and b). [AIMS] • Complete Final Report on the development of indicators (eg sediments, epiphytes and reproductive success) for seagrass health (objective c) [QPIF (DEEDI)]. • Complete Final Report / publication for objective (d) [JCU, GU]. • Contribute project data to the RIS reporting [AIMS, JCU, GU, QPIF (DEEDI)]. • Project leaders to participate in workshops to develop the final RIS report [AIMS].	15 June 2010	$62,000	$5,000	$10,000	$10,000

For 2009/10 outputs only	Date	MTSRF	MTSRF	MTSRF	MTSRF
Milestones		AIMS	DEEDI	JCU	GU
• Final summary of liaison activities undertaken through course of year 4 of project. [AIMS]					
Total MTSRF Funding		$248,000	$10,000	$20,000	$20,000

Project 3.7.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$298,000	-	$298,000
MTSRF Visual Documentation*	$2,000	-	$2,000
AIMS	-	$585,979	$585,979
QPIF (DEEDI)	-	-	-
JCU	-	$30,000	$30,000
GU	-	$30,000	$30,000
Indicative Total	**$300,000**	**$645,979**	**$945,979**

* A total of $2,000 is held by the RRRC for Visual Documentation for this project (see Theme 5).

AIMS Project 3.7.1 Budget 2009/10

Item	MTSRF Funds	Funds from AIMS Contrib	Total Cost
Salaries	$188,000	$176,931	$364,931
Operating *	$60,000*	**$188,546	$248,546
Travel (Research Vessel)	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$220,502	$220,502
Total	**$248,000**	**$585,979**	**$833,979**

* This includes a student stipend, production of an illustrated indicator manual, operationals for the student project, field and diving allowances, and other operational costs such as isotope, genetic and nutrient analyses.

** AIMS will provide 25 days of ship time on the RV Cape Ferguson for this project, and we will additionally use ~10 days of small boat time to access some of the inshore reef sites.

DEEDI (QPIF) Project 3.7.1 Budget 2009/10

Item	MTSRF	QPIF (DEEDI) In-kind	Total Cost
Salaries	$8,500	-	$8,500
Operating	$1,500	-	$1,500
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$10,000**	**-**	**$10,000**

JCU Project 3.7.1 Budget 2009/10

Item	MTSRF	JCU In-kind	Total Cost
Salaries	$10,000	$10,000	$20,000
Operating	$10,000	$10,000	$20,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$10,000	$10,000
Total	**$20,000**	**$30,000**	**$50,000**

GU Project 3.7.1 Budget 2009/10

Item	MTSRF	GU In-kind	Total Cost
Salaries	$10,000	$10,000	$20,000
Operating	$10,000	$10,000	$20,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$10,000	$10,000
Total	**$20,000**	**$30,000**	**$50,000**

PROGRAM 7: HALTING AND REVERSING THE DELINE OF WATER QUALITY

Project 3.7.2: Connectivity and risk: tracing materials from the upper catchment to the reef

Project Leader and Host Organisation

Mr Jon Brodie, James Cook University (JCU)

Project Team 2009/10

Title	Organisation	Role	FTE
Katharina Fabricius	AIMS	Researcher, reef ecology	0.2
Craig Humphrey	AIMS	Researcher, field and lab support	0.4
Oceanographic technician	AIMS	Field support	0.1
David K. Williams	AIMS	Oceanography	0.2
Eric Wolanski	AIMS	Researcher, oceanography	(through service contract)**
Jon Brodie	JCU	Project leader, researcher	0.1
Stephen Lewis	JCU	Researcher, biogeochemistry	0.35
Zoë Bainbridge	JCU	Researcher, geomorphology	0.5
Jennie Mallela	ANU	Researcher, coral geochemistry, ecology	0.45
Malcolm McCulloch	ANU	Researcher, coral geochemistry	Through Previous funding

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Laurence McCook, Hugh Yorkston
DEWHA	Kevin Gale
CAS	Olga Braga
Alliance for Sustainable Tourism	Annie Riddet
Terrain NRM	Allan Dale
Queensland Canegrowers	Matt Kealley
QLD Department of the Premier and Cabinet	Clare Andersen
Reef Catchments Mackay Whitsunday	Carl Mitchell
FBA	Nathan Johnston
WWF	Nick Heath, Piet Filet

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

The principal objectives of this project are to assess the risk to GBR ecosystems from the various land-sourced pollutants entering the GBR. Risk will be assessed by establishing explicit links between the sources of pollutants within catchments (land uses, land management practices), delivery of these materials to the river mouths (including trapping and transformation processes) and transport of the materials in the GBR lagoon (including trapping, transformation and storage regimes). Thus exposure of GBR ecosystems (particularly coral reefs, seagrass meadows, mangrove forests and the water column ecosystem) to land-sourced pollutants can be determined and, in combination with the known toxicities/effect concentrations of the pollutants, risk can be assessed.

Key Objectives:

(a) Tracing of materials in the terrestrial environment – generation, transport, transformation, trapping and risk.

(b) Tracing of materials in the marine environment – transport, transformation, trapping, fate and risk.

(c) Inshore-offshore sediment transport in the Wet Tropics – relationships between sediment input and transport and regional turbidity regimes.

Project / Task Methodology

Objective (a): Tracing of materials in the terrestrial environment

Responsible Personnel: Zoë Bainbridge, Stephen Lewis, Jon Brodie

The key tasks for this objective are:

- Characterise and obtain a distinct “fingerprint” of the fine sediments (mud fraction) delivered to the inshore regions of the Great Barrier Reef within the Burdekin catchment.
- Trace the transport and extent of the each sediment type through the main tributaries of the Burdekin River.
- Determine the sediment trapping capacity of estuaries and coastal zones as well the effects of the Burdekin Falls Dam during major flow events.
- Trace the runoff of pesticide residues from land use sources and in catchment waterways.

The key questions this objective will address relate to:

1. Only a small proportion (perhaps 5%) of the suspended sediment (SS) load of major rivers is transported large distances in the marine environment during major discharge events (evident from satellite images and flood plume monitoring). What is the specific origin in catchments of this small, but high risk, component and how do geology, soil type and land management practices interact to produce this presumably fine grained, non-settling suspended sediment? Areas of catchments producing this component of the SS load will be of high management priority.
2. What are the land use sources of pesticides in the Great Barrier Reef catchment area and what is the risk of pesticide runoff to freshwater ecosystems?
3. Is the Burdekin Fall Dam a highly efficient suspended sediment (SS) trap as predicted by the SedNet model with predicted trapping of 75% of inflow SS on a long-term basis? If

this is the case then there is no priority to manage soil erosion above the Dam to protect the GBR from bulk SS delivery as little of this SS will ever reach the river mouth. If however the Dam is only a low efficiency trap (as suggested from some limited monitoring data) then management of these areas above the Dam (the majority of the area of the Burdekin catchment) may still be a priority for GBR water quality management.

In Years 1-3, the project focussed on examining the land use sources and transport of pesticide residues in the catchment waterways of the Tully-Murray, Burdekin-Townsville and Mackay Whitsunday regions. We have sourced the runoff of particular pesticides to certain land uses and have assessed the risk of pesticide runoff to freshwater ecosystems. We have produced two manuscripts from our findings (Davis *et al.* in press; Lewis *et al.*, 2009). We have also quantified the sediment trapping efficiency of the Burdekin Falls Dam over Years 1-3, and a MTSRF report is being finalised with a manuscript in preparation (to be submitted in year 4).

Over Years 1-3, several (>400) suspended sediment and soil samples have been collected throughout the Burdekin River catchment. A selection of these samples is being progressively recovered (<38 µm fraction) for physical and chemical tracing analysIsland Many of these have been analysed for particle size composition and some samples are being run for mineralogical analysis by XRD. The clay mineral contents will also be quantified from this analysis to investigate the proportion of clays types (chlorite, smectite, kaolinite and illite).

In Year 4 of the project, additional soil samples will be collected and the <38 µm fraction will be recovered. A selection of the suspended sediment and soil samples will be analysed for mineralogical, trace element composition and lead isotopes at the Advanced Analytical Centre, James Cook University. Particular elements (e.g. Ti, Zr, Ca, K) and elemental ratios (Rb/Sr, Zr/Hf, Y/Ho, Th/Tl, Th/W) provide a useful complementary tool to trace sediment through a large river system.

Objective (a) outputs

In Year 4 of the project, we plan to produce the following outputs related to this task:

- A MTSRF report on sediment tracing in the Burdekin River catchment
- A manuscript on the trapping efficiency of the Burdekin Falls Dam

Objective (b): Tracing of materials in the marine environment

Responsible Personnel: Jennie Mallela, Malcolm McCulloch, Stephen Lewis, Jon Brodie, Zoë Bainbridge, Katharina Fabricius

The key tasks for this objective are:

- Examine historical changes in the delivery of terrestrial materials from the major river systems in the Cairns-Mackay Whitsunday region to the marine environment using coral cores
- Characterise and obtain a distinct “fingerprint” of the fine sediments (mud fraction) in the marine environment using their mineralogical, elemental and isotopic properties and to link these to the sediment sources of the major terrestrial catchments
- Trace the extent of pesticide residues in the Great Barrier Reef lagoon and assess their risk to marine plants

The key questions this task will address relate to:

1. Does increased SS load due to increased erosion from agricultural and urban development in major rivers lead to increased regional turbidity generated by resuspension in inshore areas of the GBR lagoon (with depths generally less than 10m)? This old question argued over by geologists/physicists (Larcombe, Ridd and colleagues) and biologists/oceanographers/geochemists (Wolanski, Fabricius, McCulloch and colleagues) is critically in need of a definitive answer if we are to justify our strategies to reduce erosion on GBR catchments as a major RWQPP action (linked in with objective c).
2. Are pesticide residues, particularly photosystem II inhibiting herbicides, a significant risk to the Great Barrier Reef species and ecosystems? These herbicides have been detected in freshwater runoff and throughout the GBR lagoon in both wet and dry seasons (but in higher concentrations in the wet season). Experimental studies have shown that similar concentrations measured in flood plumes do reduce photosynthesis in coral zooxanthellae and seagrass. However, it is not known whether actual long-term effects on coral and seagrass health are being caused by these pesticide residues.
3. How much has suspended sediment and nutrient loads increased since European settlement in regions of the Great Barrier Reef? Water quality targets set under regional water quality improvement plans and Reef Rescue may need to be better defined. Coral core records provide proxies of historical suspended sediment and nutrient runoff and thus allow a 'baseline' pre-European load to be estimated.
4. The water quality gradients off the Wet Tropics and Whitsunday Islands have been identified by several researchers (e.g. Fabricius, DeVantier, Cooper, van Woesik). How much have these water quality gradients changed since European settlement? Coral geochemical records will be used as proxies to help quantify these changes.

In Years 1-3 we have particularly focussed on the runoff of pesticide residues to the Great Barrier Reef lagoon and found that the runoff of certain herbicides, in particular diuron, atrazine, ametryn, hexazinone and tebuthiuron, are at concentrations which present a considerable risk to marine plants (Lewis *et al.*, 2009). We have also collected suspended sediment samples in river water plumes which are being recovered for tracing. A transect of coral cores have been collected through the Whitsunday Islands and selected cores have been analysed for trace element and nitrogen isotopes. A coral core collected from Dunk Island has been analysed for trace elements with a collection of coral cores from the Wet Tropics planned for June-July 2009.

In Year 4 of the project we plan to further analyse the risk of herbicide exposure to the Great Barrier Reef by examining additive effects of photosystem II herbicides. We also plan to characterise the physical and chemical composition of suspended sediments in river water plumes from the Burdekin River and sediments disturbed during resuspension events.

We also plan to analyse several coral cores from the Wet Tropics and Whitsunday Islands collected in Years 1-3 of the MTSRF program. Selected cores will be analysed for trace element ratios (Ba/Ca, Sr/Ca, U/Ca, Mn/Ca, Y, REE) and isotopes (carbon and nitrogen) to use as proxies for suspended sediment and nutrient runoff. Where available, water quality data from adjacent catchments will be exploited to validate the coral records. In addition, catchment land-use data and weather/runoff records will also be used to help interpret the coral geochemical records.

Objective (b) outputs

In Year 4 of the project, we plan to produce the following outputs related to this task:

- A manuscript assessing the additive risk of herbicide exposure to the Great Barrier Reef.
- A report on suspended sediment composition in river water plumes/resuspension events (linked to report in objective a).
- A report of results from the geochemical analysis of coral cores in the Wet Tropics and Mackay Whitsunday region.

Objective (c): Inshore-offshore sediment transport in the Wet Tropics

Responsible Personnel: Craig Humphrey, Oceanography technician, Eric Wolanski, Katharina Fabricius

This task aims at determining transport mechanisms for fine particulate matter from river mouth to inshore and offshore reefs in the Wet Tropics section of the GBR lagoon. It addresses the question "Does increased river loads of suspended sediments lead to repeated or prolonged regional turbidity from repeated resuspension in inshore areas of the GBR lagoon (with depths generally less than 10m)?" This old question is critically in need of a definitive answer if we are to justify our strategies to reduce erosion on GBR catchments as a major RWQPP action.

In Year 1 we quantified transport dynamics within the January 2007 flood plume off Tully River (published in Wolanski *et al.*, 2007). In Years 2 and 3, we set up and maintained arrays of nephelometers, wave gauges and current meters off the Tully and Murray Rivers focusing on Dunk Island, and off the Burdekin and Haughton Rivers focusing on Cape Cleveland. We also set up and maintained river turbidity loggers in the Tully, Burdekin and Ross Rivers throughout the 2008/09 wet season. Each of the six marine stations was serviced every three to six weeks throughout the dry and wet seasons. We also started developing a finite element model of the local hydrodynamics to quantify the spatial extent and duration of increased water turbidity over corals in Cleveland Bay from river runoff during the year.

In Year 4, we will complete the determination of the longevity of riverine mud and its progressive flushing in Cape Cleveland and the Wet Tropics. In May 2009, all instruments will have been replaced by arrays of state-of-the art instruments newly purchased by AIMS. These new instruments will provide comprehensive data on light, chlorophyll, turbidity, waves, currents, salinity and temperature, in response to wind and tide driven resuspension and deposition dynamics and riverine inputs. We will continue servicing these instruments throughout the coming two dry and one wet seasons. We will aim to conduct the following additional field work both in the dry and wet season:

a) Measurement of bed and suspended sediment loads using acoustic techniques: Acoustic Doppler Current Profilers (ADCPs) can be used to measure both the suspended and bed load components of sediment transport. The measurements can be made using both stationary and moving boat techniques.

b) Sediment transport using stationary techniques: A quad pod frame will be deployed with a downlooking bottom tracking ADCP and an uplooking ADCP. The downlooking ADCP measures water currents close to the bed as well as the movement of sediment along the bed. From these measurements the shear velocity responsible for sediment mobilisation and deposition can be determined as well as the total transport so that net fluxes can be derived. The frame will also contain a nephelometer for comparison with the ADCP backscatter. Sediment samples will be collected in the vicinity of the frame to determine sediment properties such as fall velocity, density of sediments and the bulk density of in situ sediments. These data are essential for sediment transport modelling.

c) Sediment transport using moving boat techniques: A bottom tracking ADCP and dual frequency echo sounder will be used together and survey transects will be done at several locations over a tidal cycle near where the frames are deployed. Using this technique both suspended and bed load sediment transport can be derived over larger spatial scales. The extent and thickness of unconsolidated sediment can also be mapped.

We will also complete the calibration, conversion of data, and will analyse and interpret the three years of wet and dry season data series of spatial and temporal changes in water quality. Finally, we will integrate the three years data from this study into a fine-scale hydrodynamics model, to quantify the spatial extent and duration of increased water turbidity over inshore corals and seagrasses. Eric Wolanski and David Williams will work together and combine the best features of the SLIM, RMA and Wolanski sediment transport models.

Objective (c) outputs

The main outcome of Objective c is to try to conclusively resolve the question whether, where and for how long inshore water clarity is affected by river discharges of fine sediments. Specifically, we will produce:

- Maps showing the spatial extent and thickness of unconsolidated sediments (if greater than 1 cm)
- Time series of sediment transport (both suspended and bed load)
- Derivation of shear stresses for sediment erosion and deposition
- Net sediment flux for suspended and bed load sediment transport
- Fine scale sediment transport models over long time scales.

Project Outputs / Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)	Report on preparation and analysis of suspended sediment samples for tracing (JCU)	November 2009
(b)	Report on 2009 collection of coral cores from the Townsville to Cairns region (ANU)	November 2009
(b)	Report on the preparation and analysis of coral cores from the Townsville to Cairns region and the Whitsunday Islands (JCU, ANU)	November 2009
(c)	Progress report on the maintenance of two instrument arrays in the Wet Tropics and off Townsville (AIMS)	November 2009
(a)	Manuscript submission on sediment trapping efficiency of the Burdekin Falls Dam (JCU)	June 2010
(a)	Final report on sediment tracing in the Burdekin River catchment (JCU)	June 2010
(b)	Manuscript submission on additive herbicide risk assessment for the Great Barrier Reef (JCU)	June 2010
(b)	Final report on geochemical records from coral cores from the Townsville-Cairns region and Whitsunday Islands (ANU, JCU)	June 2010
(c)	Maintain two transects with arrays of oceanographic instruments off Tully and off Townsville (AIMS)	June 2010
(c)	Final report on temporal dynamics in resuspension and fine sediment transport of river-derived materials (AIMS)	June 2010

Project 3.7.2 Milestone Payments 2009/10

For 2008/2009 outputs only **Milestones**	Date	MTSRF JCU	MTSRF AIMS	MTSRF ANU
Signing of contract		$35,000	$26,000	$10,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-
Report 1 submission: • Report on preparation and analysis of suspended sediment samples for tracing (JCU) • Report on 2009 collection of coral cores from the Townsville to Cairns region (ANU) • Report on the preparation and analysis of coral cores from the Townsville to Cairns region and the Whitsunday Islands (JCU, ANU) • Progress report on the maintenance of two instrument arrays in the Wet Tropics and off Townsville (AIMS)	15 Nov 2009	$35,000	$40,000	$15,000
Report 2 submission: • Manuscript submission on herbicide risk assessment for the Great Barrier Reef (JCU) • Manuscript submission on sediment trapping efficiency of the Burdekin Falls Dam (JCU) • Final report on sediment tracing in the Burdekin River catchment (JCU) • Maintain two transects with arrays of oceanographic instruments off Tully and off Townsville (AIMS) • Final report on temporal dynamics in resuspension and fine sediment transport of river-derived materials (AIMS) • Final report on geochemical records from coral cores from the Townsville-Cairns region and Whitsunday Islands (ANU, JCU) • Contribute project data to the RIS reporting [AIMS, JCU, ANU]. • Project leaders to participate in workshops to develop the final RIS report [AIMS, JCU, ANU].	18 June 2010	$62,000	$40,000	$12,000
Total MTSRF Funding		**$132,000**	**$106,000**	**$37,000**

Project 3.7.2 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$275,000*	-	$273,500
GBRMPA	-	-	-
JCU	-	$200,000	$200,000
AIMS	-	$177,987	$177,987
ANU	-	$80,000	$80,000
Total	**$275,000**	**$457,987**	**$732,987**

AIMS Project 3.7.2 Budget 2009/10

Item	MTSRF	JCU In-kind	Total Cost
Salaries	$82,257	$33,285	$115,542
Operating	$13,743	$257	$14,000
Travel *	$10,000	0	$10,000
Vessels	0	0	0
Communication / Extension	0	0	0
Capital	0	0	0
Institutional overheads	0	$144,445	$144,445
Total	**$106,000**	**$177,987**	**$283,987**

* Includes boat hire and two return flights (Townsville to Darwin).

JCU Project 3.7.2 Budget 2009/10

Item	MTSRF	JCU In-kind	Total Cost
Salaries	$96,500	$83,500	$180,000
Operating	$30,500	$20,500	$54,000
Travel	$5,000	$17,500	$19,500
Communication / Extension	-	$7,000	$7,000
Capital	-	-	0
Institutional overheads	-	$71,500	$71,500
Total	**$132,000**	**$200,000**	**$332,000**

ANU Project 3.7.2 Budget 2009/10

Item	MTSRF	ANU In-kind	Total Cost
Salaries	$20,000	$33,500	$53,500
Operating	$15,000	$8,200	$23,200
Travel	$2,000	$7,000	$9,000
Communication / Extension	-	$2,700	$2,700
Capital	-	-	**-**
Institutional overheads	-	$28,600	$28,600
Total	**$37,000**	**$80,000**	**$117,000**

PROGRAM 7: HALTING AND REVERSING THE DECLINE OF WATER QUALITY

Project 3.7.3: Freshwater indicators and thresholds of concern

Project Leader and Host Organisation

Professor Richard Pearson, James Cook University (JCU)
Professor Angela Arthington, Griffith University (GU)

Project Team 2009/10

Title	Organisation	Role	FTE
Richard Pearson	JCU	Joint project leader; aquatic ecologist	0.40
Angela Arthington	GU	Joint project leader; aquatic ecologist	0.30
Paul Godfrey	GU	Fish and general aquatic ecologist	0.50
Casual assistance	JCU	Lab and field support	0.50
Jim Wallace	CSIRO	Hydrologist, link to Project 3.7.4	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Hugh Yorkston
DEWHA	Kevin Gale
Terrain NRM	Allan Dale
WWF	Nick Heath
EPA	Niall Connolly
BDTNRM	Scott Crawford
Townsville City Council	Chris Manning
Cassowary Coast Regional Council	Damon Sydes

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

In Years 1 and 2 we developed and field tested conceptual biophysical models to identify (i) appropriate indicators of waterway health and (ii) probable thresholds of concern, in terms of contaminant concentrations, ecological processes and biodiversity, in order to develop monitoring systems as part of Integrated Reporting. In Year 3 we have continued field and laboratory work on wet tropics wetlands. We also planned to progress development of our program in the dry tropics, dependent on supplementary/ partner funds and/or postgraduate projects. We have been building on the Catchment to Reef program, which focussed on running waters, and now have a well-developed understanding of the requirements of indicator systems for tropical fresh waters. Our ultimate aim is to fully develop that indicator system for GBR waterways, to be used by relevant government and other agencies.

In Year 4 we will finalise field work in the wet tropics, and will continue postgraduate work in the dry tropics. We will draw together the results of our Catchment to Reef and subsequent research to produce reports on the ecological health of selected waterways in the GBR catchment, and on monitoring methods to determine ecosystem health of these waterways. We will run a workshop to present our findings to stakeholders and to refine our reporting and protocol development.

Key Objectives:

(a) Conduct field and laboratory research to develop physical, chemical and ecological indicators of freshwater ecosystem health in the wet and dry tropics as part of Integrated Water Quality Reporting that meets end-user needs and objectives.

(b) Identify thresholds of potential concern relating to land use, water quality, riparian condition, habitat, biodiversity and food web structure in freshwater ecosystems of the wet and dry tropics.

(c) Train new researchers via postgraduate programs that will be integral to the identification and testing of efficient and effective freshwater condition indicators in the wet and dry tropics.

(d) Provide monitoring methods, manuals and guidelines of relevance to a range of skills and end users.

Project / Task Methodology

Objective (a): Conduct field and laboratory research to develop physical, chemical and ecological indicators of freshwater ecosystem health in the wet and dry tropics as part of Integrated Water Quality Reporting that meets end-user needs and objectives

We will complete work on freshwater ecosystem health monitoring using biophysical indicators and protocols. We will review knowledge of spatial/temporal scales of indicator response to disturbance in rivers and wetlands, and identify possible spatial and temporal thresholds of potential concern in wet tropics systems (e.g. Russell/Mulgrave, Tully/Murray), using results from the literature, from our CRC Catchment to Reef program and from our MTSRF program, in relation to land use, instream and riparian habitat and water quality, flow regime, connectivity and biodiversity. We will identify knowledge gaps concerning the sensitivity of existing indicators and potential new indicators for subsequent testing. We will workshop our conceptual models and freshwater indicators with end users to ensure that they can provide the means for various user groups to monitor and interpret pressures of particular relevance to their interests and concerns in tropical waterways. These pressures are likely to include patterns and types of land use, general water quality and contaminants, hydrological regime, channel and habitat structure, alien species of plants and fish, and riparian vegetation condition.

In field and laboratory studies, potential indicators are being correlated with physico-chemical indicators of water quality, riparian influences on light and shade, stream channel condition, hydraulic habitat structure, sources of energy and food web structure along gradients of disturbance. Potential indicators include:

- Flow regime of the waterway;
- Physical condition of sites;
- Major water quality characteristics;
- Riparian condition (vegetation structure, canopy cover, weediness);
- Aquatic macrophyte cover and species richness;
- Proportion of aquatic macrophyte species that are alien;
- Species and/or family richness of invertebrates;

- Species richness and assemblage composition of fishes;
- Number and proportion of alien fish species;
- Proportion of fish abundance due to alien species;
- Food web structure and sources of energy driving aquatic food webs.

We are testing both spatial and temporal variability of such indicators in wet tropics waterways in the Tully-Murray catchment to refine our spatial/temporal understanding and conceptual /predictive models of responses to gradients of disturbances and attempt to identify thresholds of concern. We are working closely with Project 3.7.4 to link hydrology and ecology, especially in relation to connectivity and habitat and water quality. Subject to supplementary funding/co-investment, we will also progress our program in the dry tropics, following a similar process to that in the wet tropics.

Postgraduate projects to test freshwater indicators and thresholds of concern will continue in the wet and the dry tropics. Projects aim to test organism-level indicators of fish, invertebrate and plant health, as well as ecological processes, by testing response levels, rates and times, and to examine the efficacy of measurement using field surveys and laboratory work. Research on refined indicators will be linked to the broad-scale field trials.

Objective (b): Identify thresholds of potential concern relating to land use, water quality, riparian condition, habitat, biodiversity and food web structure in freshwater ecosystems of the wet and dry tropics

To provide theoretical and practical support to the research on thresholds outlined under objective (a), we will continue to assess existing approaches to determining and representing thresholds of potential concern, such as water quality guidelines (e.g. ANZECC Guidelines), benchmarking methods such as those applied in Queensland Water Resource Plans, and other approaches used globally (e.g. in South Africa).

Objective (c): Train new researchers via postgraduate programs that will be integral to the identification and testing of efficient and effective freshwater condition indicators in the wet and dry tropics

We will continue to support postgraduate students and link their work into this project. Supervision is shared between JCU and GU. Postgraduate projects will contribute to improving the scientific basis for selection of indicators. The following projects are completed or in progress:

- Indicators of stream ecosystem health in Mackay-Whitsunday streams – K. Leonard, MAppSci, JCU, completion in 2008.*
- Dynamics of phytoplankton and water quality in dry tropics waterways – C. Preite, PhD, JCU, completion 2009.
- Ecosystem dynamics in dry tropics waterways – M. Blanchette, PhD, JCU, completion 2011.*
- Conservation planning for wet tropics waterways – S. Januchowski, PhD, JCU, completion 2011.*
- Scoping indicators of ecosystem health in floodplain lagoons – M. Ellison, Grad. Dip., JCU, completion 2009.*
- Influence of flow seasonality on the recruitment ecology of riverine fishes from lowland wet tropics rivers – Paul Godfrey, PhD, GU, completion 2009.*

* Partly or wholly funded through MTSRF

Objective (d): To provide monitoring methods and guidelines of relevance to a range of end users

Our biophysical models, indicator development and threshold identification will provide the underpinning science for the development of monitoring guidelines that will be useable by a variety of parties, including government agencies, industry bodies, community groups and landholders. In 2009-2010 we will complete our field and laboratory work and concentrate on the major outputs of the research. Outputs will be guided by user input, via a workshop mid-term. We will provide a scientific background to waterway ecosystem health monitoring, conceptual models of stressor-response relationships, a process for indicator selection, field techniques and monitoring methods, data analysis and modeling requirements, and guidelines on the establishment of monitoring programs of relevance to a range of people, skills and end users.

Project Targeted Activities 2009/10

Objective	Targeted Activity	Completion Date
(a), (b)	Update biophysical models of the ecological consequences of changes in landscape stressors in the tropics, and proposed biophysical indicators of freshwater ecosystem health	Dec 2009
(a)	Test spatial and temporal variability of freshwater indicators in the Tully-Murray catchment – field work	Dec 2009
(a)	Subject to supplementary funding, report on preliminary field work and desk-top review of Burdekin system	Dec 2009
(a)	Complete laboratory work on 200/9 samples for the Tully/Murray, refine summary conceptual models and identify key research issues to support development of new or refined indicators.	Dec 2009
(c)	Develop and support postgraduate projects	ongoing
(d)	Workshop to determine end-user-agreed products from the program	Feb 2010
(d)	Complete reporting of research program	June 2010

Project Outputs/Outcomes

Outputs of objectives a, b, d and e will be formal reports on ecosystem health in wet tropics waterways, and a guide to monitoring protocols as determined from the research program and as advised by the proposed workshop.

Projected outcomes are (i) enhanced understanding of ecosystem health and its assessment in waterways of the wet tropics and, to a lesser extent, the dry tropics; improved knowledge in the community of the importance of ecosystem health in wet and dry tropics waterways; and (iii) adoption of monitoring protocols by relevant agencies and other bodies.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)-(c)	• Progress update for activities listed against objectives a-c (above) describing work achieved to date, including research findings. • Plan of communication outputs and products for Year 4 and summary of any liaison activities undertaken to date.	Nov 2009
(d)	• Stakeholder-researcher workshop	Feb 2010
(a)-(d)	• Progress update for activities listed against objectives a-d (above) describing work achieved to date and paln for completion. • Outline of communication outputs and products for Year 4 and summary of any liaison activities undertaken to date.	Ongoing
(a)-(b)	• Project outcomes will contribute to RIS reporting; participants will contribute to workshop to develop final report addressing RIS requirements.	June 2010

Project 3.7.3 Milestone Payments 2009/10

For 2009/10 outputs only Milestones	Date	MTSRF JCU	MTSRF GU
Signing of contract	2009	$30,000	$30,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Progress update for activities listed against objectives a-c (above) describing work achieved to date, including research findings. • Plan of communication outputs and products for Year 4 and summary of any liaison activities undertaken to date.	15 Nov 2010	$20,000	$20,000
Report 2 submission: • Stakeholder-researcher workshop	15 Feb 2010	$20,000	$20,000
Report 3 submission: • Final report on the freshwater indicators suitable to operationalise into a water quality monitoring program- with appropriate attribution to MTSRF funding. Includes preliminary report on assessment of thresholds of concern. Targeted at EPA, NRM Boards and DNRW. • Outline of communication outputs and products for Year 4 and summary of any liaison activities undertaken to date.	1 June 2010	$16,500	$16,500
Total MTSRF Funding	**$173,000**	**$86,500**	**$86,500**

* Total excludes $2,000 held for Visual Documentation.

Project 3.7.3 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$173,000	-	$173,000
MTSRF Visual Documentation*	$2,000	-	$2,000
JCU	-	$137,000	$137,000
GU	-	$105,000	$105,000
Total	**$175,000**	**$242,000**	**$417,000**

* A total of $2,000 is held by Reef and Rainforest Research Centre for Visual Documentation for this project (see Theme 5).

JCU Project 3.7.3 Budget 2009/10

Item	MTSRF	JCU In-kind	Total Cost
Salaries	$56,000	$137,000	$193,000
Operating	$22,500	-	$22,500
Travel	$4,000	-	$4,000
Communication / Extension	$4,000	-	$4,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$86,500**	**$137,000**	**$223,500**

GU Project 3.7.3 Budget 2009/10

Item	MTSRF	GU In-kind	Total Cost
Salaries	$56,000	$105,000	$161,000
Operating	$22,500	-	$22,500
Travel	$4,000	-	$4,000
Communication / Extension	$4,000	-	$4,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$86,500**	**$105,000**	**$191,500**

PROGRAM 7: HALTING AND REVERSING THE DELINE OF WATER QUALITY

Project 3.7.4: Wetlands and floodplains: Connectivity and hydro-ecological function

Project Leader and Host Organisation

Dr Jim Wallace, CSIRO

Project Team 2009/10

Title	Organisation	Role	FTE
Jim Wallace	CSIRO	Project leader; hydrology expertise	0.34
Mohammed Karim	CSIRO	Hydro-dynamic modeler	0.70
Anne Henderson	CSIRO	Hydrological GIS modeling	0.1
Aaron Hawdon	CSIRO	Flood water quality sample processing	0.1
Rex Keen	CSIRO	Flood water quality sample processing	0.1
Richard Pearson	JCU	Aquatic ecology; links to Project 3.7.3 and to other relevant research	0.05
Niall Connolly	JCU	Aquatic ecology; links to Project 3.7.3	0.05
Jon Brodie	JCU	Water quality; link to Project 3.7.2	0.1
Damien Burrows	JCU	Wetland rehabilitation; link to wetlands research program	0.05
Marcus Sheaves	JCU	Estuarine ecology	0.05
Angela Arthington	GU	Aquatic ecology; links to Project 3.7.3 and to other relevant research	0.05
Brad Pusey	GU	Freshwater fish ecology	0.05
Steve Mackay	GU	Freshwater plant ecology	0.05
Rod Connolly	GU	Estuarine ecology	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Donna Audas
DEWHA	Kevin Gale
Reef Water Quality Partnership	Rachel Eberhard
Tully-Murray Floodplain Committee	Keith Nobel, Paul Devine
Cassowary Coast Regional Council	Damon Sydes
Alliance for Sustainable Tourism	Annie Riddet
Terrain NRM	Allan Dale
Queensland Canegrowers	Matt Kealley
EPA	Mike Ronan
WWF	Nick Heath, Piet Fillet

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

Floodplains and wetlands are important physical and biological links in the aquatic continuum, providing unique and essential habitat and connectivity for specialist and wide-ranging fauna. Yet very little is known about the hydrological dynamics of these systems, and about the dynamics of the physical and biological connectivity through them. These systems provide access and vital habitat for iconic species such as Barramundi, but they are typically badly managed, highly impacted and, in the case of freshwater wetlands, severely depleted (~75% of such wetlands in GBR catchments having been lost to agricultural and other development). Proper management will depend on understanding the biophysical relationships and connectivities in these systems. This project will develop a core floodplain hydrological model to quantify two important aspects of hydro-ecological functioning: (i) sources, sinks and transport of sediments and nutrients across floodplains and (ii) connectivity of wetland systems within floodplains. In parallel, via close links with MTSRF Project 3.7.3, we will develop conceptual models of the ecological dynamics of these systems and how these interact with the hydrological processes. Ecological work to test the models of ecological processes and dynamics will be carried out in our sister MTSRF Project 3.7.3.

The overall objective of this project is to develop the capability to predict the impacts of changes in land use, management and climate on the flow and water quality regimes and ecological dynamics in the wetlands and floodplains of catchments adjacent to the GBR. This will be achieved via the following key objectives:

(a) Quantify how the flood regime affects the main sinks and sources of sediment and nutrient and their transport across floodplains.

(b) Develop a model to predict how the hydrological response and connectivity of tropical floodplains are affected by land use, land and water management and climate.

(c) Develop models that link ecological structure (e.g. biodiversity, community patterns) and processes to the core floodplain hydrology model to quantify the consequences of changes in water body connectivity between freshwater and saline waterways for biodiversity, biological connectivity and proper ecological function.

This project will make links with several other MTSRF and non-MTSRF Projects, particularly Project 3.7.3, and CSIRO and other wetland-orientated research. We will hold a second eco-hydrological Workshop to review progress in this area and will involve representatives from all relevant MTSRF water quality projects. There will be particularly strong links with Projects 3.7.1 and 3.7.2 as they will be working in the marine environment adjacent to the Tully-Murray catchments. The biophysical information generated by this project will be linked with appropriate socio-economic aspects of land use change via the economic case studies that Project 3.7.5 will carry out in the Wet tropics. Socio-economic links will also be strengthened via the geographical co-location of Project 3.7.4 and social and economic studies funded by CSIRO WFHC in the Tully-Murray catchments.

Project / Task Methodology

Objective (a): Quantify how the flood regime affects the main sinks and sources of sediment and nutrient and their transport across floodplains

We will use a novel approach that combines state-of-the-art remote sensing and ground based data with the development of a hydrodynamic model of floodplain inundation. It will

build on hydrodynamic modelling work already carried out by Main Roads in the Tully-Murray catchments in support of the redesign of the road south of Tully. The Main roads model only deals with water quantity and so this project will focus on developing and testing the sediment and nutrient transport routines that will quantify the sinks, sources and movement of materials across the floodplain during flood events. These important processes are not dealt with in existing sediment and nutrient transport models (e.g. SedNet), yet the floodplain is the area where much of the pollutants arise and it is also the area where most management interventions can take place.

The high resolution topography needed for accurate hydraulic modelling on low relief floodplains has been acquired from airborne laser altimetry. These data also give important information on the hydraulic roughness of the vegetation on the floodplain, an essential parameter in the hydrodynamic model of the floodplain, and drainage channel networks and cross sections that are needed for the connectivity work in objective (b) below. Historical and current flood extents can be obtained using SAR (Synthetic Aperture Radar) and other remotely sensed data.

The hydrodynamic model predictions of flood depth, flow velocity and direction and sediment and nutrient concentrations will be tested using a combination of manual and automatic sampling of these variables during flood events. As it would be prohibitively expensive to apply the fully hydro-dynamic model to all of the floodplains in the GBR catchments, transferability of the main model will be explored via a parallel CSIRO project that will quantify flood loads for all GBR rivers.

Objective (b): Develop a model to predict how the hydrological response and connectivity of tropical floodplains are affected by land use, land and water management and climate

The hydrodynamic model developed above will also be used to calculate wetland connectivity and how this would vary under land use and climate change. By overlaying the new Queensland Wetland Program map of the current wetlands (permanent and ephemeral) with dynamic simulations of the evolution of flood waters it will be possible to quantify the timing and duration of hydrological connections between wetlands. The model will also be able to quantify the degree of connectivity of different wetlands (e.g. how many other water bodies are they connected to, how far away are they and how long do they stay connected?).

Using historical flood frequency data it will also be possible to characterise the frequency with which different wetland bodies are flooded and how these frequencies change with climate, land use and management changes. For example, it should be possible to quantify how a range of wetland connectivity indices have changed since the introduction of flood levees and cane drains. The impacts of future options for the introduction and/or removal of drains, levees and artificial wetlands on the wetland connectivity of the entire floodplain should also be predictable.

Objective (c): Develop models that link ecological structure (e.g. biodiversity, community patterns) and processes to the core floodplain hydrology model to quantify the consequences of changes in water body connectivity between freshwater and saline waterways for biodiversity, biological connectivity and proper ecological function

The core hydrodynamic model developed above will provide a range of new opportunities to explore the interactions between flood regimes, water quality and aquatic productivity and biodiversity. In particular the model will allow wetland connectivity and fish passage during and after flood events to be studied. This will be delivered via close links with Project 3.7.3 looking at the ecological condition of a range of wetlands and the biological processes that affect the migration of tropical fish between the floodplain wetlands and freshwater streams.

Several ongoing PhD studies have been targeted at field sampling to test flow-habitat-ecology relationships and models for test locations in the wet and dry tropics.

Project Outputs/Outcomes

1. The key **Outputs** (products/results/tools) emerging from this MTSRF project that will contribute to increasing North Queensland's sustainability are:
   a. Hydro-ecological data and models that will help predict the impacts of changes in land use, management and climate on the flow and water quality regimes and ecological dynamics in the wetlands and floodplains of catchments adjacent to the GBR;
   b. Models that quantify the role of over bank floods on the transport of sediment and nutrient and their transport across floodplains;
   c. A novel hydrodynamic model that predicts how the hydrological response and connectivity of floodplain wetlands are affected by land use, land and water management and climate (in collaboration with Project 3.7.3); and
   d. Hydro-ecological models that link ecological structure (e.g. biodiversity, community patterns) and processes to the core floodplain hydrology model to quantify the consequences of changes in water body connectivity between freshwater and saline waterways for biodiversity, biological connectivity and proper ecological function (in collaboration with Project 3.7.3).

2. The main **Outcomes** that should result from this project are:
   a. The setting of realistic marine load targets that take into account the role of floods in delivering sediments and nutrients to the GBR lagoon;
   b. Improved management of agricultural and non-agricultural (e.g. wetland) areas to improve water quality entering the GBR lagoon;
   c. The opportunity to improve the classification of the state and health of tropical wetlands using quantitative connectivity criteria; and
   d. Better guidelines for prioritising investment in wetland and riparian zone rehabilitation.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)	Finalize development of hydro-dynamic model and do all model runs needed to make final estimates of flood borne loads of sediment and nutrients to the ocean adjacent to the Tully-Murray catchments	December 2009
(b)	Do all model runs needed to finalize estimates of wetland connectivity using the hydro-dynamic model and link to appropriate aquatic ecological impact models.	April 2010
(c)	Hold second Eco-hydrological Workshop (jointly with MTSRF Project 3.7.3) to review progress and identify research priorities and ways to implement results.	April 2010
(d)	Complete linked hydrological and ecological PhD studies	June 2010
(e)	Write up and publish results in report, Journal paper and Thesis forms.	June 2010
(f)	Project data and reports will contribute to the RIS reporting and project staff will participate in workshops to develop the final RIS report.	June 2010

Project 3.7.4 Milestone Payments 2009/10

For 2009/10 outputs only **Milestones**	Date	MTSRF CSIRO
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report 1 submission: • Input into progress update for activities listed against objectives (a)-(e) (above) [JCU] • Input into progress update for activities listed against objectives (a)-(e) (above) [GU] • Progress update for activities listed against objectives (a)-(e) (above) [CSIRO] • Evidence that hydrodynamic model development for material transport and wetland connectivity is nearing completion [CSIRO]	30 December 2009	86,750
Report 2 submission: • Input into final hydro-dynamic modeling progress report, including a summary of linked ecological modeling work [GU] • Input into final hydro-dynamic modeling progress report, including a summary of linked ecological modeling work [JCU] • Final report that quantifies the role of over bank floods on the transport of sediments and nutrients and their transport across floodplains in the wet tropics (with appropriate attribution to MTSRF funding) [CSIRO] • Final report predicting how the hydrological response and connectivity of floodplain wetlands are affected by land use, land and water management and climate (with appropriate attribution to MTSRF funding) [CSIRO]	1st June 2010	86,750
Information transfer between agencies: • Data collected in this project by CSIRO, JCU and GU will be made freely available amongst these parties on request. Responsible officers: J Wallace (CSIRO), R Pearson (JCU) and A Arthington (GU) • Meta-data describing all data generated by MTSRF Project 3.7.4 lodged on the e-Atlas		
Total MTSRF Funding		**$173,500**

Project 3.7.4 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$173,500	-	$173,500
MTSRF Visual Documentation*	$1,500	-	$1,500
CSIRO Water for a Healthy Country Program	-	$150,000	$150,000
CSIRO Division of Land and Water	-	$50,000	$50,000
Total	**$175,000**	**$200,000**	**$375,000**

***A total of $1,500 is held by Reef and Rainforest Research Centre for Visual Documentation for this project (see Theme 5)

CSIRO Project 3.7.4 Budget 2009/10

Item	MTSRF	CSIRO In-kind	Total Cost
Salaries	$132,500	$41,968	$174,468
Operating	$19,000	-	$19,000
Travel	$7,000	-	$7,000
Communication (incl. Workshop)	$15,000	-	$15,000
Capital	-	-	-
Institutional overheads	-	$158,032	$158,032
Total	**$173,500**	**$200,000**	**$373,500**

PROGRAM 7: HALTING AND REVERSING THE DECLINE OF WATER QUALITY

Project 3.7.5 (Includes Project 3.7.6) Socio-economic constraints to and incentives for the adoption of land use and management options for water quality improvement

Project Leader and Host Organisations

Dr Martijn van Grieken, CSIRO

Project Team 2009/10

Title	Organisation	Role	FTE
Martijn van Grieken	CSIRO	Program leader and resource economist	0.50
Peter Thorburn	CSIRO	Cropping systems scientist	0.10
Tony Webster	CSIRO	Agronomist	0.30
Jody Biggs	CSIRO	Cropping systems modeler	0.15
Scott Wooldridge	AIMS	Marine impact and link to 'Climate change' Project 2.5i.4.	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	
DEWHA	Kevin Gale
Reef Plan / Reef Regulations	
Terrain NRM	Allan Dale
WWF	Nick Heath

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

Halting and reversing the decline in water quality from rural and urban areas in North Queensland's catchments requires the adoption of land use and management options that are less water polluting. In cases where these 'best' land use and management options provide a *private* benefit to the agent[12], adoption generally occurs naturally over time provided there is access to good information and extension networks. In cases where these 'best' land use and management options do not provide a private benefit to the agent but a *social* benefit to the community, we need to focus on those options that are most cost-effective in reducing water pollution and identify instruments[13] that are most effective in promoting the adoption of these 'best' land use and management options. Focusing on the

[12] Agents include agricultural land users (e.g. sugarcane, grazing, horticulture and forestry industry).

[13] Drivers include price incentives, taxes and regulations.

adoption of most cost-effective land use and management options allows for the maximum water quality outcomes at the lowest possible costs.

This project evaluates the socio-economic constraints to and risks associated with the adoption of land use and management options for water quality improvement at the private and social level, to identify and assess instruments that are most cost-effective in promoting the adoption of these 'best' land use and management options by community embedded agents in rural and urban areas in North Queensland's catchments.

Key Objectives

(a) Assess the cost-effectiveness of land use and management options for water quality improvement, including agricultural as well as non-agricultural diffuse and point sources.
(b) Identify agent profiles, aspirations and attitudes, characterising (private) agent specific constraints to and risks associated with the adoption of land use and management options for water quality improvement.
(c) Identify and assess instruments that are most effective in promoting the adoption of 'best' land use and management options by community embedded agents.
(d) Explore sustainable resource use and water quality targets as well as associated land use and land management patterns in a linked terrestrial and marine ecosystem.

Project / Task Methodology

The project will deliver an approach that allows for the rapid identification of constraints to and assessment of instruments for the adoption of land use and management options for water quality improvement in North Queensland's catchments, thus aiding in removing the gap between current water quality levels and future water quality targets.

This project uses inputs from and provides key inputs to several projects in the Water Quality Program (Projects 3.7.3 and 3.7.7) as well as Climate Change Program (Project 2.5i.4) and the Sustainable Use Program (Project 4.9.6):

In addition, the project builds on work developed within CSIRO's Water for a Healthy Country – Great Barrier Reef flagship as well as associated projects within the Coastal Catchments Initiative (CCI).

Case studies will be developed in the Wet Tropics and Dry Tropics of North Queensland, in alignment with the above mentioned projects, to ensure that the developed approach can be applied throughout the North Queensland's catchments. Case study areas include the Tully-Murray catchment and the Burdekin catchment.

Changes have been made to ARP4 in accordance with the RRRC and DEWHA.

Project Outputs/Outcomes for 2009/10

Assessment of the implementation costs and benefits[14] of current and future land management options (BMPs) for water quality improvement for the GBR Catchment, including:

[14] *The assessment of long term production values and input and operational cost components for prioritized BMPs will take place only for fertilizer management practices in the sugarcane industry using APSIM in combination with cost benefit analysIsland

- Identification of most important agricultural production systems in the GBR catchment from both a financial (regional income) as well as a water quality point of view;
- Identification of BMPs for each identified production system;
- Prioritization of BMPs according to water quality improvement potential;
- Assessment of long term production values and input and operational cost components for prioritized BMPs[15]; and
- Assessment of the implementation costs of prioritized BMPs.

Project 3.7.5 Milestones (Payments) 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**CSIRO**
Signing of contract		$35,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Throughout the year: • Participate in workshops to develop the final report addressing RIS requirements. • Establish and maintain linkage with and contribute to the Paddock to Reef Monitoring and Modeling initiative (Reef Rescue) metrics work.	-	-
Report 1 submission: • Report on the identification of most important agricultural production systems in the GBR catchment from both a financial (regional income) as well as a water quality point of view. • Report on the identification of BMPs for each identified production system. • Report on the prioritization of BMPs according to water quality improvement potential.	1 December 2009	$40,000
Report 2 submission: • Progress report on the assessment of long term production values and input and operational cost components for prioritized BMPs (see footnote). • Progress report on the assessment of the implementation costs of prioritized BMPs.	16 March 2010	$40,000
Report 3 submission: • Final report on the assessment of the implementation costs and benefits of current and future land management options (BMPs) for water quality improvement for the GBR Catchment. • Contribute to RIS reporting.	16 June 2010	$35,000
Total MTSRF Funding		**$150,000**

[15] The assessment of long term production values and input and operational cost components for prioritised BMPs will take place only for fertiliser management practices in the sugarcane industry using APSIM in combination with cost benefit analyses.

Project 3.7.5 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
Indicative MTSRF	$150,000	-	$150,000
CSIRO	-	$100,822	$100,822
Indicative Total	**$150,000**	**$100,822**	**$250,822**

CSIRO Project 3.7.5 Budget 2009/10

Item	MTSRF	CSIRO In-kind	Total Cost
Salaries	$96,000	-	-
Operating	$30,000	-	-
Travel	$18,000	-	-
Communication / Extension	$6,000	-	-
Capital	-	-	-
Institutional overheads	-	$100,822	$100,822
Total	**$150,000**	**$100,822**	**$250,822**

PROGRAM 7: HALTING AND REVERSING THE DECLINE OF WATER QUALITY

Project 3.7.7: Analysis and synthesis of information for reporting credible estimates of loads for compliance against targets and tracking trends in loads

Project Leaders and Host Organisations

Dr Petra Kuhnert, CSIRO

Project Team 2009/10

Title	Organisation	Role	FTE
Petra Kuhnert	CSIRO	Lead statistician	0.30
Brent Henderson	CSIRO	Statistician	0.25
You-Gan Wang	CSIRO	Statistician	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
QNRW	David Roberts, Simon Catzikiris, Rob De Hayr
DEWHA	Kevin Gale
Reef WQ Partnerships	Rachel Eberhard
Terrain NRM	Allan Dale
GBRMPA	Hugh Yorkston
James Cook University	Jon Brodie, Stephen Lewis, Zoe Bainbridge

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

The export of pollutants from coastal catchments has important implications for the health of the Great Barrier Reef (GBR). Regional Natural Resource Management Plans and Water Quality Improvement Plans seek to improve coastal water quality and are underpinned by a set of load-based targets for these pollutants (e.g. sediments, nutrients).

There is a strong need to identify appropriate statistical methods for reliably estimating annual pollutants loads (with some measure of uncertainty) based on monitoring data, and assessing progress towards defined loads targets When pollutant load data is collected over a number of years there is also a need for methods for assessing trends in those loads.

In collaboration with QNRW and Terrain NRM and stakeholders from the Reef Rescue Task Force, this project will synthesise existing knowledge and information, and where necessary develop methods, for evaluating and reporting pollutant loads from the GBR catchments. This synthesis is essential to the development of common agreed approaches across all regions for measuring loads and assessing them relative to targets. Pilot subcatchment areas will be identified in the wet and dry tropic regions and used to demonstrate the

approaches. The approach will be tested for use for identifying priorities for the Reef Rescue Plan.

The **key project objectives** over the 2007-2010 period are to:

- Identify robust and scientifically defensible statistical methods for the estimation of annual pollutant loads, with quantified measures of uncertainty, from monitoring data for the GBR catchments. These methods need to build on existing work, consider the data availability and characteristics, and address the nature of the local environment.
- Develop approaches for reliably assessing the progress towards defined loads targets and estimating trends in pollutant loads.
- Conduct case studies in the wet and dry tropics in collaboration with NRW regional groups to demonstrate the performance of these methods.
- Test approaches for use by the Reef Rescue Plan
- Develop a communication strategy for reporting pollutants loads and the progress towards defined targets over both time and space. This will identify those aspects that need to be reported as a part of giving a credible load assessment.
- Inform the current monitoring so that it may be adapted, where necessary, so as to provide more accurate and precise load estimates.

Project / Task Methodology

Project tasks for 2009/10

The proposed tasks for 2009/10 (Year 4) will focus on nutrients and sediment only and are as follows:

1. Operationalise the methodology developed in Year 2 for end users (e.g. QNRW) to enable them to implement and apply the approach to catchments within the GBR. One or more workshops may be required to achieve thIsland
2. Examine the adequacy of current monitoring activities in the GBR so that it may be adapted, where necessary and provide more accurate and precise load estimates. This will involve finalising the simulation study explored in Year 2 and developing scenarios that illustrate the monitoring required to detect specific changes (power analyses). It will also consider the adequacy of the current monitoring to attribute any observed changes to key management interventions in the GBR catchments. It may be necessary to consider the sampling regime against requirements for model calibration and a range of different water quality variates given they may respond to discharge in different ways.
3. Provide input into the Reef Rescue Plan reporting process which relates to loads. The application of the methodology to priority catchments identified in the GBR will be a focus, with loads estimates feeding into the final reef report.

Project Outputs/Outcomes

The major outcomes of this project are as follows:

1. Finalise paper for MODSIM conference and present methodology and application of the methods to GBR catchments [Task 1].
2. Hold a workshop with relevant end users to discuss loads methodology and its application to GBR catchments [Task 2].
3. Paper outlining current monitoring activities in the GBR and their adequacy for calculating loads and detecting change [Task 3].
4. Handover of methodology and relevant R code to end users, namely QNRW [Task 4].

5. Finalise papers which outline the loads methodology and its application to two case studies in the GBR [Task 4].
6. Provide input into the reporting of loads in the final reef report in collaboration with Jane Waterhouse and Michelle Devlin [Task 5].

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
1	Present loads methodology at MODSIM conference	20 July 2009
2	Hold a workshop with end users to showcase the methods and obtain feedback.	15 Dec 2009
3	Provide input into the current monitoring regime and its adequacy for calculating loads and detecting change in GBR catchments.	26 Feb 2010
4	Hand over the loads methodology to QNRW. This will include a short report which outlines the methodology and its implementation in R and one or more papers that outlines the methodology and its application.	31 May 2010
5	Provide input into the Reef Rescue Plan reporting process.	31 May 2010

Project 3.7.7 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**CSIRO**
Signing of contract		$25,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
• **Progress report** on the power analysis to detect change in loads in GBR catchments.	15 November 2010	$25,000
• **Progress report** on the loads methodology, workshop, handover and uptake of methods.	15 February 2010	$25,000
• **Final report** (which may comprise a collection of papers) that outlines (1) methodology, (2) advice on monitoring activities in the GBR via simulation study, and (3) highlighting any research gaps identified through this funding round. Input will be provided into the final reef report.	15 June 2009	$25,000
Total MTSRF Funding		**$100,000**

Project 3.7.7 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$100,000	-	$100,000
CSIRO	-	$55,844	$55,844
Total	**$100,000**	**$55,844**	**$155,844**

CSIRO Project 3.7.7 Budget 2009/10

Item	MTSRF	CSIRO In-kind	Total Cost
Salaries	$90,000	$55,844	$145,844
Operating	$2,000	-	$2,000
Travel	$8,000	-	$8,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$100,000**	**$55,844**	**$155,844**

THEME 4
SUSTAINABLE USE AND MANAGEMENT

Sustainable use of North Queensland's natural assets, the Great Barrier Reef and the Wet Tropics rainforests, is critical to maintaining the environmental, social and economic values of the region. The research to be undertaken will provide knowledge and options for promoting sustainable use and minimising adverse impact on these natural assets.

Theme 4 Budget Summary

Program	Title	MTSRF	Other Cash	In-kind	Total
Program 8	Sustainable Use – Great Barrier Reef	$1,055,000	$150,000	$2,025,702	$3,230,702
Program 9	Sustainable Use – Rainforests	$1,203,275	$246,450	$1,353,377	$2.803,102
Total		**$2,258,275**	**$396,450**	**$3,379,079**	**$6,033,804**

The total value of Theme 4 is $6,033,804.

PROGRAM 8
SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Program Leader and Host Organisation

Dr Colin Simpfendorfer, James Cook University (JCU)

Program 8 Budget Summary

	Cash	In-kind	Total
MTSRF	$1,055,000	-	$1,055,000
Other	$150,000	$2,025,702	$2,025,702
Total	**$1,205,000**	**$2,025,702**	**$3,230,702**

This research Program will provide strategic research directions for the sustainable use and management of the biodiversity and natural resources of the Great Barrier Reef (GBR) with respect to ecological, social and economic sustainability. The Program is highly integrative, both within and across Programs, and has an over-arching theme related to the effects of the GBR Zoning Plan, with an emphasis on biodiversity resource use in inshore habitats. The Program addresses specific critical issues of end user relevance that align directly with the MTSRF Priority Research Areas and key questions and products. The Program captures the major gaps in knowledge for sustainable use and management of marine resources in the GBR, and provides a basis for additional targeted projects to be undertaken, which will have direct relevance to end users. The research will occur throughout the GBR and involve large-scale, integrated projects of a multi-disciplinary and collaborative nature involving the key end users. Expected outcomes from the Program include:

1. A state-of-the-art biophysical larval dispersal model and direct measures of connectivity and dispersal for coral trout that will ground-truth the model and provide information on whether green zones augment larval supply to exploited fish populations. The principal outcome of this Project is an understanding of the spatial scale of connectivity via dispersal of fish larvae, and the provision of more realistic measures of dispersal and connectivity than are available at present. Knowledge of this is essential for intermediate goals such as modelling fishing impacts on biodiversity and testing the effectiveness of the Zoning Plan.
2. An ecological assessment of the influence of the GBR Zoning Plan on inshore and inter-reefal (i.e., shoals) habitats and biodiversity of the GBR. The inshore areas of the GBR are strongly influenced by recreational and community use. Social and economic dimensions of the impacts and use on the inshore biodiversity will be linked through Project 4.
3. An analysis of the biological parameters and current and historical patterns of use of key inter-reef fish species.
4. An evaluation of the impact from industry and community uses on inshore biodiversity. Very little is known about the impacts on biodiversity from industry and community activities in this area. Historically, research has focused on the main targeted species of the line and net fisheries without considering broader biodiversity impacts.
5. An investigation of the effects (costs/benefits) of the GBR Zoning on use (tourism, recreation and fishing) of the GBRWHA. The economic analysis component of this

Project will be deferred until adequate capability has been developed in North Queensland through a CSIRO/JCU cooperative arrangement.

6. Determination of the social and economic values of key marine species, particularly large fish around tourist facilities. In addition, the Project will identify annual visitor usage patterns of the GBR to enable the identification of key trends and drivers of visitor patterns and economic impacts of visitation. Impacts of tourist and visitation to critical reef sites and sustainable levels of visitation to these sites will be assessed. This Project will provide a link with the Inshore Biodiversity Project on irukandii movement and habits and the risk of human encounters to irukandji and other marine stingers that may influence tourist visitation.

Projects

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.1: Resilience and connectivity

Project Leader and Host Organisation

Professor Terry Hughes, James Cook University (JCU)

Project Team 2009/10

Title	Organisation	Role	FTE
Terry Hughes	JCU	Project Leader	0.05
Geoffrey Jones	JCU	Co-chief investigator, Part 1a,b. Reef-fish ecologist	0.10
Garry Russ	JCU	Co-chief investigator, Part 1a,b. Reef-fish ecologist	0.10
Lynne van Herwerden	JCU	Geneticist	0.10
Jeffrey Leis	AM	Chief investigator, Part 1a,a Larval-fish biologist	0.20
Luciano B Mason	AMC	Modeller/oceanographer	0.33

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Martin Russell
DEWHA	David Osborne, Stephen Oxley
Tourism alliance	Melinda Connolly
Terrain NRM	Allan Dale
QPIF	Malcolm Dunning
WWF	Ghislaine Llewellyn

Project Duration

Start Date: November 2006 End Date: 30 June 2010

Project Description / Task Objectives

Understanding the scale of larval dispersal is a major challenge in marine ecology and it is clear that management of marine fishes, including by marine protected areas (MPAs), must incorporate the scales over which their populations are connected by larval dispersal. No-take MPAs (green zones) in the GBR promote the abundance, size and reproductive potential of exploited fishes within their boundaries, but an important question remains unanswered: (1) Do recruit fishes from adults that are protected in green zones contribute to sustaining populations within their boundaries; (2) Do green zones provide a recruitment subsidy to exploited fish populations such as coral trout beyond their boundaries (blue zones), thereby promoting the resilience and sustainable exploitation of fish resources? This project combines sophisticated larval dispersal modelling and new larval tagging approaches

to provide answers to these questions, which are critical to the assessment of the effectiveness of the GBR Zoning model.

The following specific will be addressed:

1. What is the spatial scale of connectivity by larval fish dispersal within the GBR?
2. How much do green zones contribute to the recruitment of coral trout and other fish species in blue zones (via larval connectivity)?
3. To what extent are populations in green zones sustained by their own reproduction (via larval retention)?
4. Are particular areas especially important sources of larvae for blue zones?
5. Are particular areas sustained by retention or by dispersal?

Key Objectives:

a. Develop and test realistic larval-fish dispersal models for the GBR.
b. Develop and test methods to ground-truth larval-fish dispersal models for the GBR.

Project / Task Methodology

The two parts (Objectives (a) and (b)) of this Project run in parallel. Leis and oceanographic modeller Mason will develop realistic dispersal models for the GBR that can be used both for forecasting and hindcasting (Objective (a)). Likewise, Jones leads a team including experts on marine reserves (Russ), otolith microchemistry (Thorrold) and genetics (van Herwerden) to provide empirical estimates of dispersal and ground-truth the models, with a emphasis on three recreationally important fishes: (1) coral trout (*Plectropomus maculatus*), (2) stripey snapper (*Lutjanus carponotatus*), and (3) the long-finned rock cod (*Epinephelus quoyanus*) (Objective (b)).

Objective (a): Develop realistic larval-fish dispersal models for the GBR

Collaboration between biologists and oceanographers will produce true biophysical dispersal models for larval fishes on the GBR by integrating new biological data on larval-fish behaviour into an upgraded, existing physical dispersal model. This will give the first realistic predictions of larval fish dispersal and hence population connectivity for reef fishes. These estimates of scale (dispersal kernels, or the spatial probability of dispersal) are essential for understanding how GBR fish populations are structured and for their efficient management. Outcomes are biophysical models to predict and hindcast dispersal and connectivity, and better understanding and management of GBR fish populations.

Objective (b) Develop two methods of tracking reef fish larvae and test larval-fish dispersal models for the GBR

This part will involve developing and test two new techniques that will revolutionise the direct assessment of larval dispersal. Field captures of tagged juveniles will be used to test predictions of the models (Part A). The otoliths (ear bones) of larval fish can now be safely marked by maternal transmission of stable isotopes. Also, the paternity of recruits can be established by sampling their DNA and matching it to putative parents. These two techniques will first be tested in the laboratory, then applied to coral trout, stripey snapper and long-finned rock cod in a series of capture, mark and release programs at spawning sites within selected green zones. Larvae retained within or moving beyond green zones will be identified and the direction and extent of dispersal compared with model predictions. This approach will provide the first empirical test of larval dispersal models, and will establish whether green zones augment larval supply to exploited fish populations.

As mass-marking in the field is costly, without additional co-investment, the project will be restricted to a single mass-marking and parentage study at the Keppel Islands group. A substantial proportion of adult coral trout, stripey snapper and long-finned rock cod will be captured by hook and line, and larvae will be marked by adult injections of BaCl in three green zones, with each green zone being given a unique isotope. In addition, adults will be fin-clipped for DNA fingerprinting. Juveniles (~8-16 months of age) will subsequently be collected and analysed for isotope marks and parentage to establish how many are retained within the green zone and how many disperse out into adjacent blue zones. The empirical estimates can be compared with the fine-scale biophysical model (Objective (a)), which will either be supported or modified to more accurately predict dispersal. However, the biophysical model will be based on existing larval behaviour data from a serranid species other than coral trout if co-investment to study behaviour of coral trout larvae is not forthcoming.

The program will be integrated into the existing mark-release-recapture program being coordinated by Suntag and the CapReef community monitoring program. It will therefore have a secondary goal of analyzing the movements of adult fishes, in particular adult spillover from green zones.

Project Outputs/Outcomes

1. The first realistic model of larval fish dispersal for the GBR that incorporates larval behaviour.
2. The first validated dispersal model for the GBR Marine Park.
3. The development of new methods of tracking larval dispersal for recreationally and commercially important fishes.
4. The first demonstration, using Barium tagging, parentage analysis and modelling, that adult fishes in green zones provide recruitment subsidies to blue zones.
5. A workshop and brochure for end-users on the dispersal model and larval tagging findings.
6. Publications in peer-reviewed journals.

Project Targeted Activities

Objective	Targeted Activity	Completion Date
(a) (b) (b) (a), (b) (a), (b)	• Completion of sensitivity analysis of 3D larval dispersal model. • Completion of Barium analysis of otoliths of second collection (Feb 09) of potentially marked juveniles of *P. maculatus*, *L. carponotatus* and *E. quoyanus*. Comparison of distance and direction of dispersal of marked recruits with outputs of the larval dispersal model. • Completion of genetic parentage analysis for *L. carponotatus* and *P. maculatus.* • Dedicated program newsletter article. • Briefing to DEWHA, GBRMPA and other co-contributors.	31 Jan 2010
(a) (b) (a), (b) (a), (b)	• Finalization of biophysical model; completion of testing of model outputs; Final ground-truthing of model (based on both Barium tagging and parentage analysis for *P. maculatus* and *L. carponotatus*). • Submission of publications on empirical estimates of dispersal for barium marking and genetic parentage analysis for *L. carponotatus* and *P. maculatus.* • Completion of genetic analysis of *E. quoyanus* dispersal (if additional co-investment found). • Final end user workshop to demonstrate results of model, validation, and other outcomes of the project. • Submission of final technical report (Report 2), • Preparation of brochure on how coral trout populations respond to green and blue zones and distribute to end users.	01Jun 2010

Project 4.8.1 Milestones 2009/10

For 2009/10 outputs only **Milestones**	**Date**	**MTSRF** **JCU**
Signing of contract		$28,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report 1 submission: • Detailed progress report (with appropriate attribution of MTSRF funding) on activities conducted under objectives for (a) and (b), including: - Completion of sensitivity analysis of 3D larval dispersal model (obj. a); - Completion of Barium analysis of otoliths of second collection (Feb 09) of potentially marked juveniles of *P. maculatus*, *L. carponotatus* and *E. quoyanus* (obj. b); - Comparison of distance and direction of dispersal of marked recruits with outputs of the larval dispersal model (obj. a, b); - Completion of genetic parentage analysis for *L. carponotatus* and *P. maculates*; - Copies of briefing reports (with appropriate attribution of MTSRF funding) to DEWHA and GBRMPA on research findings to date (obj. a, b); - Plan of communication outputs and products for Year 3 and summary of any communication activities undertaken to date, incl. minutes of meetings/workshops if applicable (obj a,b).	31 Jan 2010	$35,000
• Verbal progress report by Project Leader to Operations Committee on progress of all objectives	By March 2010	$15,000
Report 2 submission: • Final technical report (with appropriate attribution of MTSRF funding) on activities conducted under objectives for (a) and (b), including: - Finalization of biophysical model; Completion of testing of model outputs; Final ground-truthing of model (based on both Barium tagging and parentage analysis for *P. maculatus* and *L. carponotatus*) (obj. a); - Submission of publications (with appropriate attribution of MTSRF funding) on empirical estimates of dispersal for barium marking and genetic parentage analysis for *L. carponotatus* and *P. maculatus*. Copies of submitted papers to be submitted to RRRC and DEWHA; - Completion of genetic analysis of *E. quoyanus* dispersal (if additional co-investment found) (obj. b); - Final end user workshop to demonstrate results of model, validation, and other outcomes of the project (obj. a); - Preparation of brochure (with appropriate attribution of MTSRF funding) on how coral trout populations respond to green and blue zones and distribute to end users. Brochures distributed to Industry (GBRMPA and CapReef), RRRC and DEWHA to receive copies of briefing reports (obj. b), • Incorporation of outputs of the 3D larval dispersal model (obj a) into the e-Atlas. • Meta-data describing all data generated by MTSRF Project 4.8.1 lodged on the e-Atlas	1 June 2010	$45,000
MTSRF Funding		**$123,000**

Project 4.8.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$123,000	-	$123,000
James Cook University	-	$224,700	$224,700
Total	**$123,000**	**$224,700**	**$347,700**

JCU Project 4.8.1 Budget 2009/10

Item	MTSRF	In-kind	Total Cost
Salaries	$60,800	$119,800	$180,600
Operating	$50,200	-	$50,200
Travel	$12,000	-	$12,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$104,900	$104,900
Total	**$123,000**	**$224,700**[#]	**$347,700**

*Includes in-kind contributions from the Australian Museum that are to be reported by JCU,

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.2: Influence of the Great Barrier Reef Zoning Plan on inshore habitats and biodiversity, of which fish and corals are indicators

Project Leader and Host Organisation

Peter Doherty, Australian Institute of Marine Science (AIMS)
Garry Russ, James Cook University (JCU)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Mike Cappo	AIMS	Shoals Task Leader	0.70
Peter Doherty	AIMS	Project Leader	0.05
Gavin Ericson	AIMS	Database/Programmer	0.05
Richard Evans	JCU	Fish biologist	0.2
Aaron MacNeil	AIMS	Biostatistician	0.2
Garry Russ	JCU	Reef Task Leader	0.2
Marcus Stowar	AIMS	Fish biologist	0.7
David Williamson	JCU	Fish biologist	0.2

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Martin Russell
AMPTO	Col McKenzie / Alan Wallish
WWF	Ghislaine Llewellyn
QPIF	Malcolm Dunning

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

This Project is part of a wider performance assessment of the new GBR Zoning Plan. Project 1.1.2 of Program 1 Status and Trends of the GBR, includes biannual assessments of the impacts on biodiversity of stopping fishing on regional clusters of coral reefs in the offshore (mid and outer-shelf) domain. This Project investigates the same basic questions for coastal habitats, where the major pressure is from recreational fishing. While the emphasis in both Projects is about the impact of the zoning upon biodiversity, especially the response of fish populations when released from fishing pressure, the wider study is also about the impacts of the new Zoning Plan upon fishers and the Tourism industry. Social and economic dimensions of this problem will be studied through Projects 4.8.4 and Project 4.8.5 of this Program.

Key Objectives:

(a) Measure the response of biological communities (fish and benthos) to differential zoning of human use on inshore coral reefs.

(b) Measure the response of biological communities (fish and benthos) to differential zoning of human use on inshore shoals.

Project / Task Methodology

Objective (a): Measure the response of biological communities (fish and benthos) to differential zoning of human use on inshore coral reefs [JCU]

The intent is to monitor the abundance of a wide range of fish and benthic invertebrates at a large number of sites on coastal reefs in four groups of islands: Palm Island, Magnetic Island, Whitsunday Island and Keppel Island The main data set would consist of twenty sites that changed from blue to green in 2004 matched with twenty control sites that remained open to fishing. In addition, the team has long-term data from another sixty sites in the Palm, Magnetic, Whitsunday and Keppel Island groups, half of which were closed to fishing in the first Zoning Plan (old green, closed 1987). The group initially identified the potential to expand the coverage of new green and fished sites to other island groups along the coast (e.g. Family, Sir James Smith, Cumberland, Northumberland and Duke Island groups), representing a further eighteen paired contrasts (36 sites). Co-investment funding (CRC Reef residual) was granted in 2007/08 to survey these sites for the first time. However, advice from the AIMS LTMP field team suggested that these island groups are subject to very poor visibility and strong currents. Thus the chances of monitoring them effectively and regularly with UVC were poor. We have thus not proceeded to expand the coverage of inshore sites. The CRC residual funding will be used to carry out additional monitoring of existing sites (see below).

The team will monitor approximately eighty of the 100 core sites in 2009/10. This is more sites than the intended 50-60 indicated in ARP3. The original intention (ARP1-2) was that each location will be monitored twice during the lifetime of MTSRF. However, during MTSRF we will have sampled the long-term (old zoning) sites twice and the new RAP zoning sites three times (up to five years post RAP implementation). All counts of fish and benthos will be done following the same protocol of underwater visual census (UVC) that has been used since this work began more than 10 years ago. The counts will include both large and small fish species. Local stocks of the former can be expected to benefit from protection but this may be accompanied by trophic cascades where more predators mean fewer prey with possible consequences flowing on to invertebrate biodiversity (not explicitly measured here). The final output due in 2010 is expected to be a report on the impact of no-take zones upon biological communities, including potential trophic cascades within fish food webs.

Objective (b): Measure the response of biological communities (fish and benthos) to differential zoning of human use on inshore shoals [AIMS]

During the extensive community consultation that accompanied the rezoning of the Marine Park, anecdotal information emerged about the importance of submerged “shoals” and low-relief seabed features as intensified targets for commercial and recreational fishing. In the offshore domain, there was evidence of effort shift in the commercial fishery for live coral trout from shallow reef flanks to deeper inter-reefal shoals because of the more valuable red colour of coral trout living at depth. In the coastal zone, there was evidence of effort shift in the recreational fishery from shallow reefs to deeper waters away from the immediate vicinity of emergent and island fringing reefs. While part of this shift in effort may have been in response to the high fishing pressure placed upon accessible and popular reefs, technology creep (e.g., affordable colour echo sounders and GPS units) has allowed recreational fishers to find and return to small habitat features supporting alternative species. This appears to be

a major driver for increased interest in the prized red snappers (red emperor, small- and large-mouth nannygais). Fisheries managers are not well equipped to deal with this shift in fishing effort in either domain because there is almost no information about the distribution and nature of these submerged seabed habitats and their biology.

In ARP 1, AIMS searched the seafloor in the vicinity of Cairns, Cardwell, Townsville, Whitsundays, Rockhampton, and Gladstone using a multibeam acoustic swathe mapper, ground-truthed by towed video, to develop baselines in comparable "pairs" of fished ("blue") and unfished ("green") submerged shoals. The fish populations on these shoals were then sampled with baited remote underwater video stations [BRUVS] because the habitats of interest were below diving depth (i.e. >20 m).

In ARP2, the core sites (Cardwell, Townsville) were resampled with only partial success due to the exceptional wet season of 2007/08 and a very strong La Nina. On the advice of GBRMPA, Cairns shoals were abandoned because of uncertainty about the level of fishing effort there. Southern shoals (Barcoo and Karamea Banks; East and West Warregoes) were sampled intensely in order to recommend an optimal strategy for sampling large, discrete, submerged shoals. Although there were some mixed results, these large shoals showed differences in the abundance of a dozen key "target" species consistent with an effect of fishing detectable since the rezoning (blue to green) of one shoal from each pair in July 2004.

In contrast, the low relief shoals in the vicinity of Townsville known as the Magnetic Shoals did not show any impact from the rezoning despite the likelihood of good enforcement resulting in substantial differences in fishing effort on blue and green shoals. We believe that this is because the low-relief habitat is only a transient habitat for the large "target" species and that the mobility of these species soon exposes them to fishing.

In ARP3 we used our ability to assess fish abundance in deep water to investigate the abundance of fish species vulnerable to line fishing around the bases of reefs where there was evidence of strong fishing effects. We focussed on the three southern regions (Pompeys, Swains and Capricorn-Bunker Groups) where there was evidence of a sustained and growing impact of fishing upon the coral trout populations in shallow water.

Our focus in ARP3 remained on deep water coral trout, emperors, snappers, cods and tuskfish. BRUVS were used to sample fish abundance in deep (~45-60 m) water around 16 "blue/green" reef pairs where diver surveys have shown either weak or strong contrasts in coral trout abundance in shallow water.

Our second major objective in ARP3 was "desktop" work to refine the use of baited video techniques to establish definitive methods to detect differences in fish abundance and length compositions amongst "green" and "blue" reefs.

This objective was split into two studies:

1. Measurement of the variation amongst three readers, and amongst separate readings within three readers, in recording abundance and making species identifications.
2. Develop objective strategies to measure fish using stereo video to detect effects of RAP Zoning.

Those desktop studies showed almost 100% of the variation amongst tapes was due to the location of collection of the tape for the major study species – not the expertise of the reader or the time of reading. Secondly, smaller individuals of economically important species were shown to be visiting the BRUVS earlier than bigger ones, and we developed a measurement protocol to get the optimal length compositions to represent zoning effects. Such effects were

detected, with more bigger, and smaller, red emperor around the deep bases of "green" shoals, and more coral trout and Venus tusk fish above the legal minimum size around the same banks. In contrast, the unfished "controls" showed no such difference in the shape of the length compositions.

During ARP4 in 2009/010, we will aim to finalise the entire "shoals" study by re-sampling and tying the various components together. We will test if the "effect of fishing" signals detected in ARP2 for deepwater sweetlips (*Lethrinus miniatus*), snappers (*Lutjanus* spp), cods (*Plectropomus leopardus, Epinephelus undulatostriatus)* and tusk fish *(Choerodon venustus*) are more, or less, perceptible since the 2004 RAP zoning. The abundant starry triggerfish (*Abalistes stellatus*) and iodine bream (*Gymnocranius audleyi*) will be analysed as unfished "controls" to ensure comparability in habitats.

New data will be collected by:

1. Revisiting the two pairs of southern shoals [Barcoo and Karamea Banks, and the east and west Warregoes] in October-November 2009 to investigate further temporal changes in fish abundance and size. The design will include single and stereo-video BRUVS set on the shoal tops and shoal bases at the northern, southern, eastern and western ends. The fieldwork will be done by charter aboard RV "Tom Marshall" ex-Gladstone in about fourteen sea days on site. Laboratory work will include the reading of ~200 single BRUVS tapes and ~60 stereo-video BRUVS tapes [design t.b.a.]
2. Re-sampling the Cardwell pair of shoals with single BRUVS. The fieldwork will be done from AIMS vessel RV "Apollo" during one week, [depending on weather, during winter 2009] based at the Hinchinbrook shores marina. Laboratory work will include the reading of ~ 40 single BRUVS tapes.

Project 4.8.2 Outcomes

Objective (a): Measure the response of biological communities (fish and benthos) to differential zoning of human use on inshore coral reefs

Spatial zoning for multiple-use is the principal mechanism of management of the GBRMPA. The implementation of the Representative Areas Program (RAP) by GBRMPA in July 2004 expanded the no-take green zones from 4.5% to 33.4% of the GBRMP. Closing such a large area to all fishing was socially, economically and politically controversial. This made it imperative that the effectiveness of RAP be assessed. Project 4.8.2, based on inshore GBR coral reefs, is the only assessment of RAP that systematically collected data on the status of reefal organisms at sites **before** they were closed to fishing. This allows the project to compare future conditions of reefs closed to fishing against both Pre-RAP baseline conditions on those reefs and conditions on other reefs not closed to fishing. This provides a solid case to judge the effectiveness or otherwise of RAP. Five years into this project (2004-2009) we have produced compelling evidence that important target fish are recovering in newly closed areas. Combined with similar data for offshore reefs from the AIMS LTMP, the case that GBRMPA can put to all stakeholders (e.g commercial and recreational fishing groups, tourist organizations, conservation groups, the general public) of the positive effects of the RAP are convincing, The very positive results from this study, combined with results from Project 4.8.1 (measuring direct larval links between closed green zones and fished blue zones for fish of commercial and recreational fishing interest) provide a direct assessment of the effectiveness of multiple-use zoning implemented under RAP to conserve the biodiversity and ecosystem structure of the GBR.

Objective (b): Measure the response of biological communities (fish and benthos) to differential zoning of human use on inshore shoals [AIMS]

The impacts of the Zoning Plan on prized, bycatch and "unfished" species of deep inter-reef shoals have been described in two MTSRF reports published in 2008. Results demonstrated substantial increases (two-fold) in the pool of "prized" fish species around discrete southern shoals, but not on the diffuse northern shoals since the 2004 Zoning Plan. These results have been extended to the managers of the GBRMP and peak regional angling bodies (Australian National Sportfishing Association – ANSA, RecFish Australia and "CapReef") through reports and presentations. The methodologies developed to date have also been taken up by anglers in the CapReef group to conduct fishery-independent monitoring of the "deep demersal' stocks in the Capricornia region. This community-based monitoring has sparked widespread interest, and could be readily extended elsewhere on the GBRMP if suitable groups were formed.

The final outcomes of ARP3 and ARP4 will synthesise all the available information to explore how and why there were different responses to the RAP 2004 Zoning Plan detected in ARP1 and ARP2 amongst species and regions. This will enable managers and reef users to understand and appreciate better what "natural capital" is being conserved and enhanced in "Green Zones".

Project Targeted Activities 2009/10

Objective	Targeted Activity	Completion Date
(a), (b)	Submit work plan	30-Aug-2009
(b)	Complete Cardwell Shoals BRUVS sampling	01-Oct-2009
(b)	Complete BRUVS sampling of 2 pairs of Southern banks	01-Dec-2009
(b)	Progress report on field activities conducted at the Cardwell, and two southern pairs of shoals	30-Dec-2009
(a) (b)	Report progress and results from diver surveys of fished and unfished inshore fringing reefs. Report progress and results from camera surveys of fished and unfished submerged shoals. Submit progress report on tape reading analyses	31-Mar-2010
(a) (b)	Final report describing the response of biological communities (fish and benthos) to differential zoning of human use on inshore reefs Final report describing the response of biological communities (fish and benthos) to differential zoning of human use on inshore shoals	10-Jun-2010

Project 4.8.2 Milestones 2009/10

For 2009/10 Outputs Only Milestones [responsible agency identified in brackets]	Date	MTSRF AIMS	MTSRF JCU
Signing of contract		$30,000	$20,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Schedule of field activities including proposed methodology and contingency planning to complete objectives a [JCU] • Schedule of field activities including proposed methodology and contingency planning to complete objectives b [AIMS]	By 30 August 08	$30,000	$20,000
Report 2 submission: • Provide summaries of JCU data to AIMS within one month of collection. [Responsible Officer: Professor Garry Russ, JCU]. • Progress report on field activities conducted at the Cardwell, and two southern pairs of shoals [AIMS]	30 Dec 2009	$30,000	-
Report 3 submission (with appropriate attribution of MTSRF funding): • Report progress and results from diver surveys of fished and unfished inshore fringing reefs [JCU] • Report progress and results from camera surveys of fished and unfished submerged shoals [AIMS] • Submit progress report on tape reading analyses [AIMS] • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable [JCU & AIMS]	31 Mar 2010	$30,000	$20,000
Report 4 submission (with appropriate attribution of MTSRF funding): • Final report describing the response of biological communities (fish and benthos) to differential zoning of human use on inshore reefs [JCU] • Final report describing the response of biological communities (fish and benthos) to differential zoning of human use on inshore shoals [AIMS] • Final summary of communication activities undertaken through the course of Year 4 of project [JCU & AIMS] • Meta-data describing all data generated by MTSRF Project 4.8.2 lodged on the e-Atlas [JCU & AIMS]	10 Jun 2010	$27,000	$21,000
Total Funding		**$147,000**	**$81,000**

Project 4.8.2 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$228,000	-	$228,000
AIMS	-	$325,865	$325,865
JCU	-	$90,197	$90,197
Total	**$228,000**	**$416,062**	**$644,062**

AIMS Project 4.8.2 Budget 2009/10

Item	MTSRF	AIMS In-kind	Total Cost
Salaries	-	$85,159	$85,159
Operating	$30,000	-	$30,000
Travel (charter vessel costs)	$70,000	-	$70,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	$47,000	$240,706	$287,706
Total	**$147,000**	**$325,865**	**$472,865**

JCU Project 4.8.2 Budget 2009/10

Item	MTSRF	JCU In-kind	Total Cost
Salaries	$46,000	$26,197	$72,197
Operating	$25,000	-	$25,000
Travel (charter vessel costs)	$10,000	-	$10,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$64,000	$64,000
Total	**$81,000**	**$90,197**	**$171,197**

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.3: Evaluation of the resiliency of key inter-reefal fish species

Project Leader and Host Organisation

Dr Colin Simpfendorfer, James Cook University (JCU)

Project Team Commitment 2009/10

Title	Organisation	Role	FTE
Dr Colin Simpfendorfer	JCU	Responsible for overseeing and managing all aspects of the Project.	0.22
Dr Andrew Tobin	JCU	Assists with coordination of project, data analysis and reporting	0.1
Ms Leanne Currey	JCU	Biological sample processing, data analysis, write-up and database management.	1.0
Mr Aaron Ballagh	JCU	Database management	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Ashley Frisch
AMPTO	Col McKenzie
QPIF	Malcolm Dunning
WWF	Ghislaine Llewellyn

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

Changes to management of the coral reef finfish fishery in 2004 resulted in the implementation of an Individual Transferable Quota (ITQ) system for the management of all harvested reef fish. Within this system, the “other species” group comprise over fifty species and one third of the total quota; highlighting the importance of this ecological resource. However, very little is known about the life history characteristics or the patterns resource use of the species in this group. In addition, the aggregation of a large number of species into a single quota group has also increased the risk of over-exploitation of some species within this group. Consequently, there is an urgent need to examine the life history parameters of species within the ‘other species’ group in order to improve knowledge of the vulnerability and risk of over-exploitation.

The Project is comprised of two components: 1) Description of historic and current patterns of resource use of key inter-reef fish species; and 2) Estimation of biological parameters of key “other reef fish” species. Research conducted to date has completed the first of these objectives, identifying the key species taken in the fishery (see below), and demonstrating that the majority of the catch of the “other species” group is taken by recreational fishers.

The project has also processed and analysed samples from important three families to improve the knowledge of life history of species within the group.

Key Objectives:

(a) Document the resource use of "other reef fish" species in the GBR, and identify key ecologically and economically important inter-reef fish species.

(b) Estimate biological parameters for key "other reef fish" species in order to assess their vulnerability to increased fishing pressure.

Project / Task Methodology

The Project will use archived biological samples collected as part of the Effects of Line Fishing (ELF) Project that will provide information on the ecological resilience and vulnerability of key inter-reef fish species.

Objective (a): Document the resource use of "other reef fish" species in the GBR, and identify key ecologically and economically important inter-reef fish species

The first component of the Project has provided a description of historic and current patterns in resource use of key inter-reef fish species obtained from all available data sources. An analysis of current and past market values and catch levels has identified key species in the "other reef fish" group that may be subject to increased resource use in the future in response to the introduction of the GBR Zoning Plan and ITQ system.

Objective (b): Estimate biological parameters for key inter-reef fish species

The second component of the Project involves the processing of archived otolith and gonad samples collected during the ELF catch surveys for many species of "other reef fish". Samples will be processed and analysed to estimate a range of critical population parameters that indicate potential ecological resilience and vulnerability to resource use, as well as being required for key inputs into the inter-reef habitat model, including longevity, sexual pathway (i.e., gonochorism, protogyny) and size at maturity. Additional samples for species with low sample numbers will be supplemented from QPIF observer surveys, fishery-independent surveys and fleet sampling. CapReef and other community groups and fishing clubs will also be engaged to provide additional samples as required.

To determine the priority species for the project, an analysis of available data from commercial, recreational and charter fishing was undertaken in the first year of the project (Harvest patterns of the "Other Species" quota group in the Coral Reef Fin Fish Fishery). This report identified 21 key species based on landings data that were used to help identify species for which data would be most beneficial (Table 1). Not all of these species were collected as part of the ELF project, mostly because they occur either deeper (e.g. *Pristipomoides* spp.) or more inshore (e.g. *Lutjanus russelli, Epinephelus coiodes*) than the sampling effort. Of the 21 species identified, 12 have samples available from the ELF project.

In addition to the species identified through the key species analysis, the ELF project also collected a range of other species for which samples are available (Table 2). Species with 30 or less otoliths may not be reported on due to a lack of samples. Species for which previous studies have been conducted using ELF samples and data may not be included so as not to replicate data analysIsland Species for which previous analysis has occurred include *Lutjanus bohar* (Ross Marriott), *Cephalopholis cyanostigma* (Bob Mosse) *and Epinephelus fuscoguttatus* (Rachel Pears) and *E. polyphekadion* (Rachel Pears).

Table 1: Key components of the "other species" group in the Coral Reef Fin Fish Fishery as determined by analysis of harvest patterns in the major sectors. Names in square brackets are codes from the DEEDI database that do not match accepted common names. Shaded species indicate those for which samples are available from the Effects of Line Fishing Project.

Common name	Species name
Yellow-Tailed Emperor	*Lethrinus atkinsoni*
Spangled Emperor	*Lethrinus nebulosus*
Hussar (pink)	*Lutjanus adetii*
Stripey bass	*Lutjanus carponotatus*
Small-mouth nannygai	*Lutjanus erythropterus*
Black-spot snapper [Black-Spot Emperor]	*Lutjanus fluviflamma*
Large-mouth nannygai	*Lutjanus malabaricus*
Moses perch	*Lutjanus russelli*
Red emperor	*Lutjanus sebae*
Rosy jobfish	*Pristipomoides filamentosus*
Goldband jobfish	*Pristipomoides multidens*
Blue-spotted rockcod [Bommie cod]	*Cephalopholis cyanostigma*
Gold-spot cod	*Epinephelus coioides*
Black-tipped cod	*Epinephelus fasciatus*
Flowery cod	*Epinephelus fuscoguttatus*
Speckle-finned cod	*Epinephelus ongus*
Longfin rockcod [Wire-netting cod]	*Epinephelus quoyanus*
Maori cod [Cod – maori unspecified]	*Epinephelus undulatostriatus*
Bream coral	*Gymncranius audleyi*
Venus tusk fish	*Choerodon venustus*
Tusk fish [Parrotfish*]	Family Labridae

* Fish identified as parrotfish in the QPIF database are almost all tusk fish caught in the Capricorn Bunker Group.

Analysis of samples will be conducted by family to provide for comparisons within taxonomic groups. The order in which families will be examined is based on the number of species for which data are available. Families with the least data will be placed first to provide more time for data from larger families to be analysed. Two species of coral trouts (*Variola* spp) were not included in the Family Serranidae because they fall within the coral trout quota group. However, these species will be analysed in a final milestone that encompasses a few miscellaneous species so that these data are made broadly available. Also included in this final group is the humphead wrasse (*Cheilinus undulatus*). This species is listed on the IUCN Redlist (Endangered) and some life history data are available for this species (e.g. Choat *et al.* 2006[16]).

[16] Choat, J. H., Davis, C. R., Ackerman, J. L. and Mapstone, B. D. (2006) Age structure and growth in a large teleost, Cheilinus undulates, with a review of size distribution in labrid fishes. *Marine Ecology Progress Series* 318: 237-246.

Table 2: Species with biological samples available from the Effects of Line Fishing Project. Shaded species are those identified from the results of the key species analysis given in Table 1.

Family	Genus	Species	Otolith samples	Gonad samples
Labridae	*Cheilinus*	*undulatus*	71	80
Labridae	*Choerodon*	*venustus*	20	20
Lethrinidae	*Lethrinus*	*atkinsoni*	1850	727
Lethrinidae	*Lethrinus*	*lentjan*	73	74
Lethrinidae	*Lethrinus*	*nebulosus*	494	328
Lethrinidae	*Lethrinus*	*olivaceus*	70	32
Lutjanidae	*Aprion*	*virescens*	108	80
Lutjanidae	*Lutjanus*	*adetii*	150	55
Lutjanidae	*Lutjanus*	*bohar*	976	279
Lutjanidae	*Lutjanus*	*carponotatus*	4183	
Lutjanidae	*Lutjanus*	*fulviflamma*	80	51
Lutjanidae	*Lutjanus*	*gibbus*	100	67
Lutjanidae	*Symphorus*	*nematophorus*	175	63
Serranidae	*Aethaloperca*	*rogaa*	4	3
Serranidae	*Anyperodon*	*leucogrammicus*	75	35
Serranidae	*Cephalopholis*	*argus*	139	85
Serranidae	*Cephalopholis*	*cyanostigma*	2656	727
Serranidae	*Cephalopholis*	*miniata*	34	13
Serranidae	*Cromileptes*	*altivelis*	128	150
Serranidae	*Epinephelus*	*cyanopodus*	81	73
Serranidae	*Epinephelus*	*fasciatus*	848	452
Serranidae	*Epinephelus*	*fuscoguttatus*	187	213
Serranidae	*Epinephelus*	*maculatus*	82	69
Serranidae	*Epinephelus*	*merra*	23	250
Serranidae	*Epinephelus*	*ongus*	805	434
Serranidae	*Epinephelus*	*polyphekadion*	130	101
Serranidae	*Epinephelus*	*quoyanus*	183	69
Serranidae	*Variola*	*albimarginata*	39	39
Serranidae	*Variola*	*louti*	134	99

Project Outputs/Outcomes

Objective (a): Document the resource use of "other reef fish" species in the GBR, and identify key ecologically and economically important inter-reef fish species

The results of this analysis are included in a report that documents the use of the "other species" reef fish group by the commercial, recreational and charter fishing sectors. This report shows significant differences in the species taken by each sector, and how they have changed over time, especially with changes in the way the commercial fishery operates (trend towards live coral trout over time), the management arrangements of fishery (input vs output controls) and the zoning of the GBRMP. The data from this report also demonstrate that the recreational sector takes the largest share of the "other species" group (~75% by weight) and that species composition data for this sector are much poorer for this sector than for the commercial sector; while the commercial sector has not filled the available quota since ITQs were introduced and thus have the capacity to significantly increase landings of this group. Assessment of the potential risks associated with the potential increasing catches of the "other species" group will thus need to carefully consider the effect of all sectors of the fishery. The second objective of this study provides the data that will allow for the measuring of the resilience of individual species. This information will be used to inform continued improvements in the management of this diverse group of coral reef fishes.

Objective (b): Estimate biological parameters for key inter-reef fish species

This objective has been investigated using archived samples collected during the decade long ELF project. Samples from four families of coral reef fish (Labridae, Lethrinidae, Lutjanidae and Serranidae) encompassing over forty species have been processed and analysed to provide life history information (size, age, growth, mortality and reproduction) that can be used to assess the vulnerability of species historically included in the 'other reef fish' category to changes in fishing pressure brought about by changes in management arrangements. For many of these species, this is the first time that this information has been available, providing significant increases in understanding of the life histories of species comprising this important group of fishes. The output from this work is in a series of reports on the individual families. Two have been completed (Lethirindae and Lutjanidae), the third (Serranidae) is due for completion by mid 2009 and the final by early 2010. The information presented in each of these reports will be combined into a final report that examines the comparative demography of all groups combined to investigate the diversity of life history strategies used by the "other species" group and identify those species that have life history characteristics that make them most vulnerable to over-fishing.

Outputs from both objectives has been provided to stakeholder and end-users. This includes providing information to management agencies (QPIF, GBRMPA) and committees (Reef MAC, Reef SAG, FRAC) that provide advice on the Coral Reef Finfish Fishery.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(b)	Processing of remaining biological samples from Effects of Line Fishing Project. Including samples from the Family Labridae and the plectropomid serraenids	15 November 2009
(b)	Report on the biological parameters of the remaining species from the ELF Project	15 February 2010
(b)	Report on the comparative biology of all "other species" coral reef fishery species examined in Project 4.8.3.	15 February 2010
(a), (b)	Final report on the resilience of the "other species" coral reef fish group.	10 June 2010

Project 4.8.3 Milestones 2009/10

For 2009/10 Outputs Only	Date	JCU	MTSRF
Milestones – all JCU responsibilities		**JCU**	**JCU**
Signing of contract		$26,000	$10,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Report (with attribution of MTSRF funding) providing evidence of the completion of processing of all remaining biological samples of all "other species", including samples from the Family Labridae and the plectropomid serraenids.	13 Nov 2009	-	$12,000
Report 2 submisson: • Report (with attribution of MTSRF funding) on the life history characteristics of the remaining species, including samples from the Family Labridae and the plectropomid serraenids. • Report (with attribution of MTSRF funding) presenting the results of comparative analysis of the life history and resilience of the "other species" group on the Great Barrier Reef. • Meta-data describing all data generated by MTSRF Project 4.8.3 lodged on the e-Atlas	15 Feb 2010	-	$12,000
Report 3 submission: • Final report (with attribution of MTSRF funding) on the resilience of the "other species" group of coral reef fish exploited on the GBR • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable	1 June 2009	-	$16,000
Total Cash*		**$26,000**	**$50,000**

*Total excludes funds held for Visual Documentation.

Project 4.8.3 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF*	$50,000	-	$50,000
JCU	$26,000	$191,295	$217,295
Total	**$76,000**	**$191,295**	**$267,295**

JCU Project 4.8.3 Budget 2009/10

Item	MTSRF	JCU Cash	JCU – In Kind	Total Cost
Salaries	$45,000	$26,000	$11,295	$82,295
Operating	$5,000	-	-	$5,000
Travel	-	-	-	-
Communication / Extension	-	-	-	-
Capital	-	-	-	-
Institutional overheads	-	-	$180,000	$180,000
Total	**$50,000**	**$26,000**	**$191,295**	**$267,295**

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.4: Evaluation of the impacts from industry and community uses on inshore biodiversity

Project Leader and Host Organisation

Dr Andrew Tobin, James Cook University (JCU)

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Andrew Tobin	JCU	Project Leader responsible for overseeing and managing all aspects of the project.	0.85
Dr Colin Simpfendorfer	JCU	Responsible for assisting with coordination of all aspects of the project	0.68
Mr David Welch	QPIF	Responsible for coordinating the collection of field data and historical data, interpretation and analysis, and write-up	0.75
Mr Aaron Ballagh	JCU	Responsible for database management and some field work	0.1
Mr Alistair Harry	JCU	Responsible for completing a PhD related to the biology of key inshore sharks	1.0
Mr Jimmy White	JCU	Responsible for field work, biological sample processing, data entry and analyses	1.0
Dr Richard Pillans	CSIRO	Responsible for assisting with risk assessment development	0.05
Dr Malcolm Dunning	QPIF	Responsible for coordinating linkages with QPIF Assessment and Monitoring	0.05
Dr Neil Gribble	QPIF	Responsible for providing advice on the inshore fishery and assisting with risk assessment development	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Randall Owens
QPIF	Tara Smith, Malcolm Dunning
AMPTO	Col McKenzie
WWF	Ghislaine Llewellyn, Peter Trott

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This Project will evaluate the impacts on inshore biodiversity arising from industry and community uses. Fishing is the primary extractive use of inshore marine species by industry and the wider community, but currently the ecological, social and economic sustainability of this use and associated impacts on the inshore biodiversity is unknown. This Project will directly address the key MTSRF goal of sustainable use and management of natural resources by providing an understanding of the current and potential industry and community uses of inshore biodiversity and natural resources with respect to ecological sustainability and provide information and options to assist managers, industry and communities to optimise the use of biodiversity resources and minimise adverse impacts where they occur.

Specifically, this Project will provide a report on the ecological effects of the 2004 Zoning Plan on inshore biodiversity resources and a report on strategies to better mitigate the environmental impacts of the inshore finfish fishery, particularly impacts on sharks and other vulnerable species. This Project also directly supports the MTSRF Mission to facilitate capacity-building for sustainable environmental management and environmental management research by incorporating and fostering postgraduate research within the Project.

Key objectives:

(a) Characterise the industry and community use of inshore biodiversity.

(b) Evaluate the effects of current management arrangements, in particular the GBR 2003 Zoning Plan, on industry and community use of inshore biodiversity resources.

(c) Derive biological parameters, determine stock structure and identify critical habitats for key inshore species, in particular sharks, used by industry and the community.

(d) Evaluate the impacts of industry and community use on key inshore marine species, such as sharks, within the GBRWHA by identifying vulnerable species or species groups and assessing potential risks.

(e) Assess potential strategies to mitigate the impacts of industry and community use on inshore resources within the GBRWHA.

Project / Task Methodology

Objective (a): Characterise the industry and community use of inshore biodiversity

The use of inshore biodiversity by industry and the community will be characterised by analysing existing fisheries data for the inshore fishery. This will provide estimates of relative importance of species groups to the various users of the inshore biodiversity resources. Where possible, these data will be analysed within years and among regions to explore overall seasonal and regional patterns in use. Species-specific data and information on discarded bycatch species are generally not available from existing fisheries data sources. Therefore, data from previous and current research projects (DEEDI, CRC Reef, CapReef, UQ and CSIRO) will be collated to assess the extent of species-specific information available for inshore species. Where gaps are identified, additional data will be collected from observer surveys on commercial and charter vessels and boat ramp surveys for recreational fishers. Personal interviews with fishers from all sectors of the inshore fishery will be conducted as part of MTRSF Project 4.8.5. Species-specific data collected from these interviews will be made available to this Project. The collection of detailed information for the Indigenous sector is beyond the scope of this Project.

An observer survey program will be designed to capture the spatial and seasonal trends in use of inshore biodiversity within the GBRWHA. The observer program will strongly complement existing observer surveys conducted by QPIF by collecting similar information

from locations and at times not covered by the QPIF surveys. Specific data collected from observer surveys will include time spent fishing, location, depth, habitat, species composition of the harvest and bycatch, lengths of all species caught and condition of discards. Biological samples from key species will also be collected during observer surveys (see Objective (c)). Data from the QPIF observer surveys will be made available to this Project as an in-kind contribution.

Objective (b): Evaluate the effects of current management arrangements, in particular the GBR 2003 Zoning Plan, on industry and community use of inshore biodiversity resources

The patterns in use of inshore biodiversity resources by industry and the community prior to and since the implementation of the Zoning Plan will be compared to assess shifts in use of key harvested species or species groups. Personal interviews with recreational fishers are being conducted by PhD Debora de Freitas as a component of MTSRF Project 4.8.5, and are designed to elicit information about species-specific shifts in use since the implementation of the Great Barrier Reef Marine Park Authority 2004 Zoning Plan. Geographical Information Systems (GIS) will be used to map shifts in the distribution of use of the recreational fishing sector, and highlight areas of concentrated use in response to the 2003 Zoning Plan. Shifts in the use patterns of commercial fisheries utilising resources that are integral to inshore biodiversity will be investigated through analysis of historical commercial logbook records. Preliminary multi-dimensional scaling methods utilised in an earlier project report (*Review of harvest patterns and biology of key inshore species within the Great Barrier Reef World Heritage Area – Current knowledge and information gaps*), will be extended to detect changes in species utility to be mapped and referenced against the introduction of the GBRMPA 2003 Zoning Plan. This more detailed investigation will incorporate seasonal and spatial variables.

Objective (c): Derive biological parameters, determine stock structure and identify critical habitats for key inshore species, in particular sharks, used by industry and the community

Data from previous research projects (DEEDI, CRC Reef, UQ and CSIRO) will be collated to review existing biological knowledge of key inshore species at risk. This process will identify species for which biological information is lacking or insufficient. Biological samples of these species will be collected during the observer surveys for Objective (a) and from targeted sampling from the commercial fleet and seafood processors. Otoliths (fin fish), vertebrae (sharks) and gonads will be extracted and processed to provide estimates of age, sex and stage of sexual development. Additional features will be measured for sharks including clasper length and rigidity and presence of sperm in sperm ducts for males, and uterus width and presence of eggs or pups for females. These data will be used to estimate longevity, growth rates, mortality rates, size and age at first maturity and fecundity for key species or species groups. Fin clips from samples will be used for genetic analysis using mitochondrial and microsatellite markers to examine the stock structure and potential movements of key species, in particular sharks. Additional information on dietary preferences will be obtained where possible from stomach contents. Critical habitats for key species will be identified by linking the catch and effort data from observer surveys to life stages identified through biological examination.

A PhD student (A. Harry) with relevant experience in fisheries research will contribute to the completion of this objective. Harry will be located at JCU and supervised by JCU Project staff.

Objective (d): Evaluate the impacts of industry and community use on key inshore marine species, such as sharks, within the GBRWHA by identifying vulnerable species or species groups and assessing potential risks

A risk assessment framework specifically tailored for the assessment of tropical sharks has been developed by an expert panel of shark researchers from QPIF and CSIRO. This framework will be used as a basis to assess the potential vulnerability of species to current patterns in use of inshore biodiversity resources by industry and the community. The established risk assessment model will be refined to incorporate data collected from the first three objectives of this Project, including relative harvest rates, biological characteristics, discard practices, stock structure and estimates of the survival rates of released species. The presence in other fisheries within the GBRWHA of species identified during this process as being at risk to over-exploitation will be identified. Information on the use of these species from other fisheries will be incorporated into a refined risk assessment to provide a more comprehensive assessment of overall risks to these species within the GBRWHA.

Objective (e): Assess potential strategies to mitigate the impacts of industry and community use on inshore resources within the GBRWHA

Based on results from the risk assessment (Objective (d)) and biological information (Objective (c)), the performance of a range of potential mitigation strategies including education, seasonal and area closures to fishing, reduction or redistribution of fishing effort and fishing gear modifications will be assessed for their ability to reduce the interaction of potentially vulnerable species with various fishing gears used in the inshore fishery. This objective relies heavily on the results from Objective (d) and, therefore, specific methods for assessing potential mitigation strategies will not be developed until results are known. Engagement of management and fishers in the assessment of potential mitigation strategies will be essential to ensure such strategies are effective, practical and are accepted and adopted by industry. Workshops with end users will be organised in the third and fourth years of the Project to facilitate the assessment, development and potential implementation of mitigation strategies identified as being effective.

Project motivation and relationship to other projects

The main focus of the MTSRF-funded project is the collection of information to enable an Ecological Risk Assessment (ERA) to be implemented for the inshore species taken by the major sectors. The results of the ERA will identify species that are most at risk, help identify possible solutions and provide resource managers with information on which to improve management of inshore resources of the GBRWHA. It should be stressed that this project is implementing this risk assessment for all species taken in the inshore commercial and recreational fisheries, including sharks, rays and teleost fish.

Ecological risk assessment requires a range of information that falls within two broad categories:

1. ***Life history:*** These data provide the basis for the biological sustainability and risks of a particular species. A large part of the current project is devoted to the collection of life history data that will be used in the ERA. Two approaches to collecting life history data were available in designing this project. Firstly, fishery independent sampling. This approach requires dedicating sampling by researchers, and was considered too expensive and time consuming to collect the large amount of material and data required (species and regional representation). The second approach is fishery dependent sampling where data and samples are collected by observers working either with commercial or recreational fishers. This approach was chosen for this project because it provided a cost effective method of collecting material for the project. The material collected was also from the species that are most commonly caught and thus most

needed; a problem for fishery independent approaches if sampling strategies are poorly designed. The fishery dependent approach therefore provided a representative and cost effective means of collecting life history data. The material collected is being processed to provide the required life history information. There are numerous student projects involved in the process of determining urgently needed life history parameters of both important inshore sharks [Alastair Harry, PhD; Andrew Chin PhD; Melanie Trapon, MSc] and fin fish [Aaron Ballagh, PhD; Bradley Moore, PhD; Natasha Szczcenski, MSc; Audrey Schlaff, Kim Vane, Ashlee Painter, MSc Minor Projects]. In addition, the stock structure of important inshore sharks is being investigated by MSc student Ron Schroeder. The other advantage of a fishery dependent approach was that data on the species composition of the catch could be investigated. There are limited data available on the species composition of catches in the inshore fishery, and by recording species composition while on vessels this project could also contribute to the understanding of the diversity of species encountered. These data would also help inform the ERA approach in terms of the species that needed to be included and how they interact with the fishing gear, whether they are retained or released, etc for use in the next section (susceptibility). In addition to the species composition data collected in this study, data from QPIF observer programs are also being used to help frame the risk assessment.

2. ***Susceptibility:*** These data provide an understanding of how various processes affect a given species. The most common approach is to consider a species susceptibility to a fishery (e.g. efficiency of the gear, the range of the fishery relative to the species range, release practices, etc.). This is the approach specified in the current MTSRF funded inshore project. However, the susceptibility aspect of ERA is quite open, in that it allows the inclusion of a variety of other factors that may affect a species' risk level (e.g. ecological effects such as changes in water quality, competition for resources or spatial dynamics that change susceptibility given the mosaic of management zones within the GBRWHA). Given this, a number of related projects, mostly undertaken by graduate students, have been developed that are aiming to provide additional information on this aspect of the ERA. These projects are briefly outlined below (section on Internal student projects).

In addition to the core research being carried out as part of this project, there are a number of other projects that are linked to this study that are providing additional information that will expand the scope of the ERA. These fall into two areas:

1. ***Externally funded projects:*** Three projects on the stock structure of groups of inshore species (grey mackerel, threadfin and sharks) are currently funded by FRDC. Two of these projects are investigating stock structure across northern Australia (grey mackerel and threadfin), while the third is investigating the stock structure of four species of sharks (top commercially caught species) on Queensland's east coast. These projects on stock structure are designed to provide information on the appropriate spatial scales for management of these widely-distributed stocks, but also provide ancillary information (e.g. life history data) that will be highly relevant in the ERA. A fourth project will start to develop tools for investigating the post-release survival of sharks (funding from Save Our Seas Foundation). This topic is especially important given that recreational fishers release > 95% of their shark and ray catch in the GBRWHA, and with increasing regulation commercial fishers are also required to release more individuals.
2. ***Internal student projects:*** A number of student projects are currently underway (or will be in the near future) that will provide additional data to the ERA. This includes a study on the competition for food resources by inshore predators (sharks and fish) and its implications for nursery areas (Mike Kinney, PhD); attitudes and practises of recreational fishers to sharks and rays (Ann-Maree Lynch, Hons); spatial dynamics of inshore predators in relation to a marine protected area (Danielle Knip, MSc); and methods for

evaluating post-release stress and survival in sharks and rays (Cynthia Awruch, postdoc).

All of these projects have some level of linkage to the core MTSRF-funded project. Some utilise samples collected during fishery dependent sampling (e.g. shark stock structure), while others feed samples in to the MTSRF project (e.g. grey mackerel and threadfin stock structure). This synergy between projects provides for outputs that are greater than could be achieved by projects individually.

Project Outputs/Outcomes

Objective (a): Characterise the industry and community use of inshore biodiversity

The inshore biodiversity of inshore waters of the GBRWHA is very diverse, with commercial and recreational fishers catching hundreds of species, including groups of increasing conservation concern such as sharks and rays. This objective is being addressed in two ways: firstly by reviewing historic information on catches by inshore fishers, and secondly by initiating new data collection processes.

(i) ***Historic data:*** In the first year of the project a report "*Review of harvest patterns and biology of key inshore species within the Great Barrier Reef World Heritage Area*" was produced. This report scoped all major existing data opportunities and provided a detailed view of the composition of the commercial and recreational catch in inshore waters of the GBRWHA. It identified major gaps in knowledge regarding the composition of the catch, in particular in relation to the shark and ray catch of both commercial and recreational fishers, and in the species composition of the catch of fish by recreational fishers. Given the growing concerns about the sustainability of shark and ray populations on Queensland's east coast, this report highlighted the need to dramatically improve understanding of the take of sharks and rays by all inshore fisheries to improve management. The report also identified gaps in the biological knowledge of key inshore shark and fish species that formed the basis of directed life history research being conducted by post graduate students (detailed previously).

(ii) ***New data collection:*** Data collection using observers on commercial fishing vessels and boat ramp surveys for recreational fisher have been conducted since the first year of the project. The collection of these data has provided new insights into the catch of both sectors of the inshore fishery and has already contributed to improved regulation in the inshore fishery. Data collected includes not only information on species and size composition of the catch, but also large amounts of biological data and samples to help fulfill Objective (c). The new data on the commercial catch of sharks and rays have been especially valuable, and revealed that up to forty species are regularly caught by commercial fishers. This catch has largely been reported in commercial logbooks as "unidentified shark". The shark species and size composition data has been provided to QPIF to assist in the development of new regulations for sharks in the inshore fishery.

Objective (b): Evaluate the effects of current management arrangements, in particular the GBR 2003 Zoning Plan, on industry and community use of inshore biodiversity resources

This objective has received a preliminary assessment through the earlier project report *Review of harvest patterns and biology of key inshore species within the Great Barrier Reef World Heritage Area*, where shifts in the use patterns of inshore biodiversity by the commercial fishery were documented between years and at the whole of fishery scale. Preliminary multi-dimensional scaling analysis revealed a distinctive change in the utility of inshore biodiversity in response to the implementation of the GBRMPA 2003 Zoning Plan. These analyses will be further extended in the final year of the project to investigate finer

spatial and seasonal characters of these already identified broad scale shifts in use of inshore biodiversity.

Objective (c): Derive biological parameters, determine stock structure and identify critical habitats for key inshore species, in particular sharks, used by industry and the community

The commercial fishery observer trips have generated a large amount of biological data and samples for life history studies of sharks, ray and fish species. In addition, fishery-independent sampling has also been conducted in the Townsville region to provide data not available through commercial observers, including a tag recapture and calcein injection studies to assist with age validation. Much of this work is being undertaken by postgraduate students (detailed previously) under the supervision of JCU staff. The main parameters being examined are size and age frequency, age and growth parameters and reproductive biology. The information gap analysis conducted as part of Objective (a) has helped focus this work on key species. Shark and ray species for which life history research is underway includes: Australian blacktip, common blacktip, blacktip reef, scalloped hammerhead, great hammerhead, spottail, milk, whitecheek, creek whaler and fossil sharks, and giant shovelnose and white-spotted guitarfish. Fish species for which life history research is underway include: king threadfin, blue threadfin, whiting, garfish and grunters. The life history data collected under this objective will be incorporated into the ecological risk assessment as part of Objective (d).

Objective (d): Evaluate the impacts of industry and community use on key inshore marine species, such as sharks, within the GBRWHA by identifying vulnerable species or species groups and assessing potential risks

This objective will be addressed during the final year of the project and will develop an ecological risk assessment for the inshore species that are taken by commercial and recreational fishers. The risk assessment will include data on both the biological productivity (and hence ability to sustain exploitation) and susceptibility to various forms of fishing (both commercial and recreational). This will provide resource managers with measures of risk associated with the exploitation of individual species and assist with refining management of these resources.

Objective (e): Assess potential strategies to mitigate the impacts of industry and community use on inshore resources within the GBRWHA

This objective will be addressed in conjunction with Objective (d) by using the ecological risk assessment to investigate how mitigation measures such as size and bag limits, closed areas, and gear selectivity may change the risks associated with take of key species.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(b)	Completion of analysis of data on the composition of catches of commercial and recreational fishers in inshore fisheries of the GBRWHA, including specific information on the effects of the 2004 zoning plan on shifting use patterns where they have occurred.	15 November 2009
(c)	Completion of analysis of biological data on key species exploited by commercial and recreational fishers in inshore waters of the GBRWHA	15 February 2010
(d), (e)	Completion of Ecological Risk Assessment for inshore biodiversity, including investigation of potential strategies to mitigate the impacts of industry and community use on inshore resources within the GBRWHA	1 June 2010
(a)-(e)	Stakeholder and end user meeting to provide results of the project and discussion of outcomes.	1 June 2010

Project 4.8.4 Milestones 2009/10

For 2009/10 outputs only	Date	Payments		
		JCU	MTSRF	
Milestones			JCU	CSIRO
Contract signing		$94,000	$60,000	$2,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-
Report 1 submission: • Report (with appropriate attribution of MTSRF funding) detailing the final catch composition of commercial and recreational inshore fisheries in the GBRWHA, including specific information on the effects of the 2004 zoning plan on shifting use patterns where they have occurred.	15 Nov 2010	-	$60,000	$1,000
Report 2 submission: • Final report (with appropriate attribution of MTSRF funding) on the biological characteristics of key inshore species, including sharks and fish.	15 Feb 2010	-	$60,000	$1,000
Report 3 submission: • Final risk assessment report (with appropriate attribution of MTSRF funding) for inshore biodiversity, including investigation of potential strategies to mitigate the impacts of industry and community use on inshore resources within the GBRWHA. • Workshop report from meeting with stakeholders and end users to outline research results. • Meta-data describing all data generated by MTSRF Project 4.8.4 lodged on the e-Atlas	1 June 2009	-	$62,500	$1,500
Total Funding		**$94,000**	**$242,500**	**$5,500**

Project 4.8.4 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$248,000	-	$248,000
James Cook University	$94,000	$708,645	$802,645
QPIF	-	$50,000	$50,000
Total	**$342,00**	**$758,645**	**$1,100,645**

JCU Project 4.8.4 Budget 2009/10

Item	MTSRF	JCU Cash	In Kind	Total Cost
Salaries	$198,500	$94,000	$50,000[QPIF]	$342,500
Operating	$31,000	-	-	$31,000
Travel	$13,000	-	-	$13,000
Communication / Extension	-	-	-	-
Capital	-	-	-	-
Institutional overheads	-	-	$708,645[JCU]	$708,645
Total	**$242,500**	**$94,000**	**$758,645**	**$1,095,145**

CSIRO Project 4.8.4 Budget 2009/10

Item	MTSRF	In Kind	Total Cost
Salaries	$5,500	-	$5,500
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$5,500**	**-**	**$5,500**

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.5: Incorporating stakeholders and their values, knowledge and aspirations in the care and development of the Great Barrier Reef Marine Park

Project Leader and Host Organisation

Dr Stephen Sutton, James Cook University (JCU)

Project Team Commitments 2009/10

Title	Organisation	Role	FTE
Dr. Stephen Sutton	JCU	Project Leader responsible for overseeing and managing all aspects of the project.	0.60
Dr. Renae Tobin	JCU	Post-doctoral fellow with socio-economic research experience employed to conduct data collection and analysis and report writing.	0.40
Ms. Elodie Ledee	JCU	Research Assistant	0.50
Ms. Ann Penny	JCU	Research Assistant	0.40
Ms. Debora DeFreitas	JCU	PhD Student	0.25

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Randall Owens, Roger Beeden
AMPTO	Col McKenzie
CapReef	Bill Sawynok
DEWHA	Andrew McNee
Commercial Fishing	Carl D'Aguiar
Charter Fishing	Ray Joyce
QSIA	TBA
QPIF	John Kung
Sunfish	David Bateman
WWF	Ghislaine Llewellyn

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

The overarching goal of this Project is to provide information that will enhance our capacity to incorporate social considerations in decision making, predict, evaluate and mitigate negative social impacts of changes in policy or resource condition, and facilitate the development of community partnerships and community engagement in research and management of the Great Barrier Reef World Heritage Area (GBRWHA).

Specific objectives of the project are:

(a) Understand and document the influence of the 2003 GBR Zoning Plan on use (tourism, recreation, and fishing) of the GBRWHA and users.

(b) Develop, test, and parameterise a set of indicators that can be used to assess change in the socio-economic environment of GBRWHA use in response to policy or environmental changes.

(c) Understand community attitudes, knowledge, and concern regarding climate change and its potential impacts on the GBR, and provide information in support of increased community engagement in GBR climate change management actions.

Project / Task Methodology

Element 1: Analysis of existing data

Objectives (a) and (b)

Existing sources of information will be sourced, collated, and analysed to predict and assess potential influence of the 2003 GBR Zoning Plan on GBR users. Available data sources include (but are not limited to): CRC Reef tourism surveys and surveys of recreational, commercial, and charter fishers; media articles about the influence of the Zoning Plan; historical catch and effort data from commercial, recreational, and charter fishers; and catch and effort data collected through the QPIF RFISH and CFISH programs.

Element 2: GBR user interviews

Objectives (a) and (b)

Face-to-face interviews will be conducted with a random sample of approximately 200 GBR users including tourism operators, recreational fishers, and commercial fishers to assess and understand the socio-economic influence of the 2003 Zoning Plan. Changes in reef-use patterns will be recorded on maps and entered into GIS for archiving and analysIsland Additional questions will focus on attitudes and knowledge concerning the Zoning Plan, user characteristics, and involvement in the rezoning public consultation program. The survey will also collect information necessary to parameterise the social indicators identified in the framework currently being created by GBRMPA/JCU through a MTSRF bridging-fund project (see Element 3 below). The survey will build on research undertaken by the Project Leader under CRC Reef Task 1.2.3b “Understanding the effects of management changes in the GBR on the recreational fishing community” by expanding the data collected to include geographic areas outside the CapReef study area (i.e., the Rockhampton/Gladstone region), and by including the tourism and commercial fishing sectors.

Element 3: Development of a socio-economic indicators monitoring system.

Objective (b)

Through a project funded through MTSRF bridging funds, researchers at GBRMPA and JCU began the process of developing a framework to monitor socio-economic variables related to

use of the GBR and incorporate this information into management. The surveys to be undertaken in Element 2 above will build on the GBRMPA/JCU project by collecting data to parameterise the indicators identified through that project, and by providing industry-specific indicators that can be used in other evaluative frameworks (e.g., fishery indicators to be used in fisheries Management Strategy Evaluations). To provide a link between this Project and the GBRMPA/JCU project, a one-day workshop will be conducted in Townsville to discuss and refine further information needs and issues related to the use of socio-economic indicator information.

The workshop will include a selected group of representatives of major reef user groups (tourism, recreational fishing, commercial fishing), and relevant fisheries and marine park managers, and scientists. The major outcome of the workshop will be a list of social and economic indicators to be parameterised through Elements 1 and 2 above.

Element 4: Community survey of climate change knowledge and concern

Objective (c)

A telephone survey will be conducted to explore and document community knowledge, attitudes, etc regarding climate change and the GBR. The survey will cover the area adjacent to the GBR and the east coast capital cities of Brisbane, Melbourne, and Sydney. The telephone survey methodology used will be based on the methods developed and used successfully in CRC Reef Task 1.2.3b to survey recreational fishers in Queensland. The sample size of 1,600 individuals will be sufficient to segment the population according to demographic and psychological factors, and explore differences in attitudes toward, knowledge of and concern about climate change.

Project Outputs / Milestones

Objective	Output / Milestone	Completion Date
(a) (b)	Collate existing information relevant to assessing influence of the Zoning Plan. Conduct the socio-economic indicators workshop. Industry and other end user magazine article. Dedicated program newsletter article.	December 2006
(a)	GBR user survey and sampling plan developed. Commence analysis of existing data and GBR user survey. Briefing to DEWHA, GBRMPA RACs, CapReef, and industry.	June 2007
(c)	Dedicated program newsletter article. Industry and other end user magazine article.	December 2007
(a) (b) (c)	Develop telephone survey instrument. Briefing to DEWHA, GBRMPA, CapReef, and industry.	June 2008
(a) (c)	Complete user interviews and telephone survey. Dedicated program newsletter article. Industry and other end user magazine article. Briefing to GBR Operations Committee	December 2008
(a) (c)	Complete data entry into GIS and statistical databases. Analysis of interview and survey data commenced. Briefing to DEWHA, GBRMPA, CapReef, GBR Operations Committee and industry.	June 2009
(a) (c)	Complete data analysIsland Dedicated program newsletter article. Industry and other end user magazine article.	December 2009
(a) (b) (c)	Technical reports and relevant scientific peer-reviewed publications. Briefing to DEWHA, GBRMPA, CapReef, and industry.	June 2010

Project 4.8.5 Outcomes

Objective (a): Understand and document the influence of the 2004 GBR Zoning Plan on use (tourism, recreation, and fishing) of the GBRWHA and users

The impacts of the Zoning Plan on recreational fishers have been described in a MTSRF report published in 2008, and in a manuscript currently in review in Environmental Conservation. Results demonstrated substantial support for the 2004 Zoning Plan among recreational fishers, despite anecdotal evidence to the contrary. Results also demonstrated that recreational fishers' support for future GBR management initiatives can be generated and maintained by ensuring that fishers understand the long-term conservation and fisheries benefits of management initiatives, and by ensuring that the recreational fishing community is meaningfully engaged in the decision-making process.

Analysis of the spatial impacts of the Zoning Plan on recreational fishing effort is included in a PhD thesis by Debora Defreitas to be submitted to JCU in 2009. Results demonstrate that there was significant displacement of recreational fishing effort due to the Zoning Plan. Displacement of fishing effort was generally towards inshore areas, and to areas that already received significant recreational fishing effort, suggesting that some areas may now be at risk from localized depletion caused by concentration of fishing effort. These results suggest that potential displacement effects need more consideration in any future zoning changes.

Data collected for the charter and commercial fishing sectors are being analysed and in a similar manner as the recreational fishing data. These data will be included in a MTSRF technical report due in the last half of 2009.

Objective (b): Develop, test, and parameterise a set of indicators that can be used to assess change in the socio-economic environment of GBRWHA use in response to policy or environmental changes

A stakeholder workshop was held in 2007 to begin the process of identifying appropriate indicators for the various GBR user groups. A list of potential indicators was developed at that workshop and presented in a MTSRF milestone report submitted in 2008. Over the past two years, we have been collecting socio-economic data from the various fishing GBR user groups in support of refining and paramaterizing the indicators. The indicator framework will be described in a MTSRF report due in 2010

Objective (c): Understand community attitudes, knowledge, and concern regarding climate change and its potential impacts on the GBR, and provide information in support of increased community engagement in GBR climate change management actions

We surveyed 1,600 Australian residents by telephone in November 2008. Preliminary data analysis indicates that there is a high level of awareness about climate change, its causes, and its potential impacts on the GBR among the Australian community. Likewise, there is a high level of concern about the impacts of climate change on the Great Barrier Reef, and a corresponding high level of desire among individuals to increase their engagement in climate change reduction and mitigation efforts. However, most individuals surveyed reported not being able to engage in climate change actions to the extent they desire due to a range of constraints on their actions (e.g., not knowing what else they can do to help). Results suggest that efforts to increase community engagement in GBR climate change actions need to be refocused on understanding the constraints to engagement that individuals encounter, and helping people negotiate these constraints. Less effort needs to be directed at educating the public about climate change and its causes and impacts: this knowledge is already well established in the Australian population. A report outlining these results will be submitted to MTSRF and GBRMPA in the second half of 2009, with a number of peer reviewed publications submitted to appropriate scientific journals before the end of 2009.

Project 4.8.5 Milestones 2009/10

Objective	Targeted Activity	Completion Date
a, b, c	• Finalize report describing the attitudes of the general public toward climate change. • Finish analysis of the impacts of 2004 Zoning Plan on commercial and charter fishers. • Complete a draft socio-economic indicators monitoring system.	15 Jan 2010
a, b, c	• Deliver report describing the impacts of the 2004 Zoning Plan on commercial and charter fishers. • Deliver report outlining the social indicators monitoring system. • Summary of any communication activities undertaken including minutes of meetings/workshops if applicable. • Submit articles describing the impacts of the zoning plan on commercial, recreational, and charter fishers, and articles describing the attitudes of the general public toward climate change to peer reviewed journals.	1 June 2010

Project 4.8.5 Milestone Payments 2009/10

For 2009/10 outputs only	Date	JCU	MTSRF
Milestones		**JCU**	**JCU**
Signing of contract		$30,000	$25,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Final report (with appropriate attribution of MTSRF funding) on the community survey of climate change issues. • Draft report (with appropriate attribution of MTSRF funding) outlining the impacts of the 2004 Zoning Plan on commercial and charter fishers. • Draft report (with appropriate attribution of MTSRF funding) outlining the social indicators monitoring system. • Dedicated program newsletter article (including appropriate attribution of MTSRF funding). • Progress briefing to DEW, GBRMPA, CapReef, and industry.	15 Jan 2010	-	$49,000
Report 2 submission: • Final report (with appropriate attribution of MTSRF funding) outlining the impacts of the 2004 Zoning Plan on commercial and charter fishers • Final report (with appropriate attribution of MTSRF funding) outlining the social indicators monitoring system • Summary of any communication activities undertaken including minutes of meetings/workshops if applicable. • Report on peer-reviewed articles published, submitted, and in-prep arising from the Project • Meta-data describing all data generated by MTSRF Project 4.8.5 lodged on the e-Atlas	1 June 2010	-	$49,000
Total Cash		**$30,000**	**$123,000**

Project 4.8.5 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$123,000	-	$123,000
JCU	$30,000*	$240,000	$270,000
Total	**$153,000**	**$240,000**	**$393,000**

*Co-investment by JCU to cover thirty percent of PI salary.

JCU Project 4.8.5 Budget 2009/10

Item	MTSRF Cash	JCU Cash	JCU In-kind	Total Cost
Salaries	$115,000	$30,000*	$40,000	$145,000
Operating	$5,000	-	-	$5,000
Travel	$3,000	-	-	$3,000
Communication / Extension	-	-	-	-
Capital	-	-	-	-
Institutional overheads	-	-	$200,000	-
Total	**$123,000**	**$30,000**	**$240,000**	**$153,000**

* Co-investment by JCU to cover thirty percent of PI salary.

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.6: Analysis of recreational and tourism use and impact on the Great Barrier Reef for managing sustainable tourism

Project Leader and Host Organisation

Professor Bruce Prideaux, James Cook University (JCU)

Project Team Commitments

Title	Organisation	Role	FTE
Prof Bruce Prideaux	JCU	Principle Investigator 1 Task Objectives d	0.3
Prof Glenn Ross	JCU	Principle Investigator 2 Task Objectives d	0.1
Dr Alexandra Coghlan	JCU	Post Doctoral Research Fellow Task Objective d	1.0
Dr Alastair Birtles	JCU	Principle Investigator 1 Task Objectives a and b	0.2
Assoc Prof Peter Valentine	JCU	Principle Investigator Task Objective a and b	0.1
Dr Natalie Stoeckl	JCU	Principle Investigator 3 Task Objectives a and b	0.1
Marina Farr (Research assistant);	JCU	Task Objective a & b	0.2
Arnold Mangott and Matthew Curnock (PhD students)	JCU	Task Objective a & b (2009 only)	0.2
Research Officer	JCU	Task Objectives a & b (2009/10)	0.7

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	Lisha Mulqueeny
TTNQ	Annie Riddet
AMPTO	Col McKenzie / Alan Wallish
WWF	Samantha Hardy

This Project links to Project 4.8.5 and will benefit from the capacity building component of Theme 5 Enhancing Delivery.

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

This project includes determination of the social values of key marine species, particularly large fish around tourist facilities, and identification of key trends and drivers of visitor patterns in the GBR and an economic analysis of the value of no-take zones to tourism in the GBR. The economic analysis will be deferred until adequate capability has been developed in North Queensland through a CSIRO/JCU cooperative arrangement. In addition, the program will identify annual visitor usage patterns of the GBR to enable the identification of key trends and drivers of visitor patterns and economic impacts of visitation. Impacts of tourism and visitation to critical reef sites and sustainable levels of visitation to these sites will be assessed. This Project will provide link with the inshore biodiversity project (Project 7) on Irukandii movement and habits, and the risk of human encounters to irukandji and other marine stingers that may influence tourist visitation.

The project is linked to Project 4.8.5, Objective (a) and (b): Understand and document the influence of the 2003 GBR Zoning Plan on use (tourism, recreation, and fishing) of the GBRWHA and users and Project 4.9.2 Sustainable Nature Based Tourism: Planning and Management. There is potential for the project to be linked to other projects within the MTSRF program

Key Objectives:

(a) Identify relative social and economic values of key marine species, particularly large fish around tourist facilities.

(b) *Evaluate management issues, risks and threats to identified high-value species to the GBR tourism industry.*

(c) Identification of key trends and drivers of visitor patterns, including assessment of the economic impacts of visitation and comparison of the GBR with international reef tourist attractions.

Project / Task Methodology

Objective (a): Identify relative social and economic values of key marine species, particularly large fish around tourist facilities

Surveys of tourists visiting the GBR and interacting with iconic marine wildlife species (e.g. minke whales, sharks and rays, turtles and large fishes such as Maori wrasse, potato cod and Queensland grouper), combined with a business expenditure survey of GBR tourism operators providing these experiences, will provide the first in-depth assessment of some of the relative social and economic values of these iconic marine species and their impact on the local and regional economy. Field assessments of the quality of key wildlife attractions, impacts and their management have been conducted with substantial in-kind support of industry. Assessment of social values requires an understanding of visitor expectations, satisfaction and perceptions of iconic wildlife species. An understanding of these social and economic values of these key species is required for a Triple Bottom Line (or Quadruple Bottom Line) evaluation of the sustainability of tourism utilising these important resources.

In ARPs 1-3, work conducted to achieve this objective was focussed primarily on specialist Reef tourism operators (live-aboard and day boat Reef tours) based in Cairns and Port Douglas, carrying between 18 and 100 passengers (although additional data are being collected from the Townsville region). In ARP4, this work will be finalised by examining the relative social and economic value of marine turtles and combining the outcomes with previous work to provide an in-depth assessment of the contribution made by iconic marine species on the local and regional economies.

Additional surveys will be conducted in ARP4 to examine the importance to tourists' experiences and their social and economic values of resident large fish (e.g. Moray eels, Maori wrasse, Queensland grouper and other serranids - that are habituated to interactions with humans using food) as well as incidental encounters with sharks and other iconic wildlife species for larger Reef tourism vessels (carrying c.400 pax) visiting pontoons, and Reef islands (including island resorts). These additional key informant surveys will be conducted on reef pontoons coral cays and GBR island resorts in both the Cairns/Cooktown and the Townsville/Whitsunday Management Areas of the GBR. The outcomes of the surveys will:

- Determine the distribution and use of iconic GBR species by large reef tourism operators;
- Identify high-value key marine species (and in some cases individual resident animals) at high-use Reef pontoons, coral cays and island resorts;
- Describe the nature of tourists' interactions and experiences with these key species and qualitatively assess the perceived relative social and economic values of these species/animals to the operators providing interactions with them;
- Allow comparison of the perceived relative social and economic values of the species/animals targeted by large pontoon or island based reef tourism operators with those values for the key marine species targeted by the specialised dive & snorkel tour operators in the GBR;
- Identify perceived threats to the key species; and
- Allow development of protocols for the management of tourists' interactions with the key species, and perceptions of their effectiveness.

Objective (b): Evaluate management issues, risks and threats to identified high-value species to the GBR tourism industry

An 'issues paper' synthesising the key findings and outcomes of Objective (a) will be prepared and circulated to stakeholders (including Reef tourism operators and managers) by April 2010. Using the issues paper as the primary input, a scoping workshop will be held in May 2010 to:

(1) Identify and evaluate the range of guidelines used for managing tourist interactions with high value marine species (indentified and valued in Objective a) around GBR tourism facilities;
(2) Identify management issues associated with tourism interactions with these species (e.g. touching, feeding);
(3) Evaluate the management of other risks and threats to these key marine species (e.g. vessel strike, fishing, entanglement, climate change), and
(4) Identify new research priorities for the sustainable management of tourism interactions with these species in the GBR Marine Park.

The workshop will involve GBR tourism operators, Reef managers and other key stakeholders.

The outcomes of the GBR tourism industry and management scoping workshop will be reported at the end of ARP4 and will include recommendations for advancing research that addresses threats to key marine species, and for improving tourism guidelines for the sustainable management of interactions with key marine species.

Objective (c): Identification of key trends and drivers of visitor patterns, including assessment of the economic impacts of visitation and comparison of the GBR with international reef tourist attractions

Visitor patterns will be identified and published as a barometer on a quarterly and annual basIsland The annual publication will link GBR visitor patterns to state, national and global trends to develop performance benchmarks with these trends. This objective will allow examination of trends and drivers that effect visitor flows to the reef as well as estimates to be made of the economic value of reef tourism. Monthly visitor surveys will be conducted with approximately 350 respondents. Marine operators will assist by distribution and collection of the surveys in five GBR regions (Port Douglas, Cairns, Townsville, Whitsunday's and the Capricorn Coast). This methodology will also enable the research team to respond rapidly to emerging issues that impact on the GBR. Specific issues that will be investigated during the project will include motivations, seasonality, segmentation and other issues including responses to global warming, the importance of photography, coral bleaching as well as an indication of the size of the dive market in the GBR. Surveys will be conducted in English and where appropriate in Japanese and Chinese. A triangulation method using participant observation and informal dialogues with tourists will increase the robustness and depth of the survey data, and ensure its representativeness. This project will, together with Project 4.9.2 provide a comprehensive picture of the pattern of tourism in the study region and allow reef tourism to be placed within the overall context of motivations to visit the study region and the range of activities engaged in once in the region. Co-investment would substantially enhance this objective.

Project Targeted Activities 2009/10

Objectives	Output / Milestone	Completion Date
(c)	Report on changes in market segmentations of reef visitors	Oct 2009
(c)	Annual Report # 3	Mar 2010
(a)	Report on social and economic values of marine turtles	Jun 2010
(a)	Final Report on the social and economic values of key marine species (all species and including the perceived social and economic values of key marine species at high-use tourism sites)	Jun 2010
(c) (a), (c)	Final synthesis report on visitor patterns, trends and drivers. Final report on economic trends.	Jun 2010
(b)	Report on the management issues, risks and threats to high-value species to the GBR tourism industry	Jun 2010

Project 4.8.6 Milestones 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones – all JCU responsibilities		**JCU**
Signing of contract		$50,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report 1 submission: • Technical report on patterns and trends in Reef tourism markets, including changes in dominant markets and differences in product requirements between market segments (Obj c). This report will provide a comprehensive analysis of major visitor segments and their characteristics, including differences and temporal changes in age, gender, activities undertaken, satisfactions levels and previous reef experience between the domestic and international market and between market segments. • Plan of communication outputs and products for year four and summary of any communication activities undertaken to date including minutes of meetings/workshops if applicable.	30 Oct 09	$40,000
Report 2 submission: • Plan for completion of activities for objective (c) including completion of remaining surveys, data collated on visitor usage of other Australian and international reef tourist attractions for comparison to data from GBR, • Visitor Survey Annual Report for the year ended December 09 with comparisons of results from previous years. This report will also include an analysis of the data collected during the life of the project and will complement Report 1 above. The report will be designed as the basis for future monitoring of tourism activity on the GBR. • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable.	31 March 2010	$40,000
• Issues Paper on management issues, risks and threats to high-value GBR species completed and distributed to project stakeholders	April 2010	$3,000
Report 3 submission: • Summary of communication activities undertaken, including minutes of meetings/workshops if applicable. • Final synthesis report on the significant trends and drivers of tourism on the Great Barrier Reef, including an analysis of surveys of domestic and international tourism conducted on the Reef, at the airport and in the rainforest (MTSRF Project 4.9.2). The report will also provide a detailed review of information gaps and provide directions for future reef tourism research. • Final report on the social and economic values of key marine species (including marine turtles) (Obj a above). • Report on the management issues, risks and threats to high-value species to the GBR tourism industry (including workshop report)	10 Jun 2010	$60,000
Total MTSRF Funding		**$193,000**

Project 4.8.6 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$193,000	-	$193,000
JCU	-	$70,000	$70,000
AMPTO	-	$80,000	$80,000
Total	**$193,000**	**$150,000**	**$343,000**

JCU Project 4.8.6 Budget 2009/10 Objective a

Item	MTSRF	In Kind	Total Cost
Salaries	$43,800	$20,000	$63,800
Operating	$6,000	$20,000	$26,000
Travel	$7,200	-	$7,200
Communication / Extension	$1,000	-	$1,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$58,000**	**$40,000**	**$98,000**

JCU Project 4.8.6 Budget 2009/10 Objective b

Item	MTSRF	In Kind	Total Cost
Salaries	$9,500	-	$9,500
Operating	-	-	-
Travel	$2,000	-	$2,000
Communication / Extension	$3,500	-	$3,500
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$15,000**	**-**	**$15,000**

JCU Project 4.8.6 Budget 2009/10 Objective c

Item	MTSRF	In Kind	Total Cost
Salaries	$100,000	$50,000	$150,000
Operating	$5,000	$60,000	$65,000
Travel	$10,000	-	$10,000
Communication / Extension	$5,000	-	$5,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$120,000**	**$110,000**	**$230,000**

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.7: Forecasting risk of exposure to irukandji

Project Leader and Host Organisation

Professor Michael Kingsford, James Cook University (JCU)

Proposed Project Team Commitment 2009/10

Title	Organisation	Role	FTE
Prof Michael Kingsford	JCU	Chief investigator	0.05
Dr Eric Wolanski	JCU	Associate investigator	0.05
Post Doc/Project funds	JCU	TBA (contingent on funding)	TBA
Dr Jamie Seymour	JCU	Principal investigator	0.05
Dr Madeleine van Oppen	AIMS	Principal investigator	0.05

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
AMPTO	Col McKenzie
GBRMPA	Chris Briggs
Surf Lifesaving Australia	TBA
Queensland Health	TBA

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

The purpose of this Project is to minimise risk to swimmers through knowledge of the sources of jellyfishes and changes in their abundance. Our focus has been on North Queensland where numbers of stings by jellyfishes have been high. We have, and will obtain, information on the abundance of jellyfishes in near reef and nearshore waters across the GBR between Cooktown and Townsville. In addition, there is a suggested link between abundance of *C. barnesi* and proximity to estuaries this has never been tested critically. The inshore zone is the area of highest use by the public and forecasting the risk of envenomation is critical. Our approach involves sampling near-shore waters near to and away from estuaries in an area of North Queensland that has high usage by tourists and locals. The coastal zone between the Daintree River and Mackay has the highest frequency of envenomation and is our area of focus. Samples of *C. barnesi* and *C. fleckeri* will be used for genetics and elemental fingerprints to determine population structure.

(a) Collect samples for the project during the stinger season from November to May.

(b) Collect jellyfishes at different distances across the GBR and at three latitudes in North Queensland in multiple years;

(c) Use elemental chemistry and microsatellites to test for differences in the population structure of *C. barnesi* and *C. fleckeri* among locations.

(d) Continue to develop risk maps for stingers including time of year, geographic variation, species distribution etc. from existing data sets and expert opinion (contingent on funding).

(e) Develop a set of response guidelines to reduce risk to human health (contingent on funding).

Project/Task Methodology

Objective (a): Collect samples for the project during the stinger season from November to May

Samples will be collected during major surveys (b) and opportunistically (e.g. from Surf Life Saving).

Objective (b): Collect jellyfishes at different distances across the GBR and at three latitudes in North Queensland in multiple years

Broad-scale surveys of cubozoans conducted over the last two summers will be repeated in summer of 2009 to 2010. Three cross shelf cruises (transects) will conducted between December 2008 and February 2009. Transects are Lizard Island, Cairns and the Palm Island Group. Cubozoans will be sampled by light attraction (1000 W bulbs) at three distance strata (inner, mid and outer). Within each distance strata sampling will be done at two sites separated by 0.7 to 3 km and at each site two replicate one hour samples will be taken for abundance data and the lights will be left on for longer for the purposes of collecting jellyfishes for genetics, elemental chemistry.

It was hypothesised that irukandji jellyfishes would be most abundant around islands; this was based on the patterns found in 2007-2008. We will test this hypothesis further by sampling distances from shore where irukandji were found the previous year. We will sample mid-shelf, on the Lizard Island transect, at two sites. Sampling will be done at two sites at Rocky Islets, a reef without islands and at a similar distance from the mainland to Lizard Island Similarly, Green Island will be sampled mid-shelf on the Cairns transect to compare with Michalemas Reef (without an island).

Data on temporal variation in abundance will be gained from Mermaid Bay (over three seasons) and Double Island (near Palm Cove).

Objective (c) Use elemental chemistry and microsatellites to test for differences in the population structure of C. barnesi and C. fleckeri among locations

We have successfully detected elements in the calcium sulphate statoliths of *Chironex fleckeri.* Our success with *Carukia barnesi* has been more limited as the statoliths are so small they are often destroyed by the Laser (LA ICP-MS). Samples are being stored to that we can carry out further analyses using genetics techniques and elemental chemistry when more jellyfish are collected.

Objective (d) Continue to develop risk maps for stingers including time of year, geographic variation, species distribution etc. from existing data sets and expert opinion (contingent on funding)

Maps have been developed and addition maps will be done based on requests from MTSRF. We can provide general advice on risk, but the data we have collected so far indicate that highly focused local data is required to provide specific advice on risks associated with a particular location.

Objective (e) Develop a set of response guidelines to reduce risk to human health (contingent on funding)

These Guidelines have already been produced but will be updated after the 2009 – 2010 season based on additional data.

Project Activities 2009/10

Objective	Targeted Activity	Date
a	Collect samples – from research vessels and jellyfishes of opportunity from the Quicksilver stinger sampling program and other marine tourism operators.	April/May 2010
b	Use microsatellites and statolith microchemistry to examine and report on the population structure of *C. barnesi* and *C. fleckeri* among locations	June 2010 continuing based on sample availability*
c	Develop risk maps for stingers including time of year, geographic variation, species distribution from existing data sets and expert opinion	June 2010
d	Guidelines for marine operators and the public to reduce the risk of exposure to marine stingers (contingent on funding)	June 2010

* The jellyfish season does not finish until May, so final analyses are partly based on availability of specimens.

Project 4.8.7 Milestones 2009/10

For 2009/10 outputs only	**Date**	**MTSRF**
Milestones – all JCU responsibilities		**JCU**
Signing of contract		$15,000
Attendance by Project Leader at Operations Committee meetings (3/year)	2009/10	-
Report 1 submission: • Schedule of field activity and communication activities for 09/10 including collaborative project meetings to assist in development of risk maps and guidelines to reduce risk of exposure to marine stingers.	10 Sept 2009	$15,000
Report 2 draft submission: • Latest guidelines for marine operators and public that identify techniques to minimize risk of exposure to marine stingers and actions to take if contact with stingers is made (with appropriate attribution to MTSRF funding). Inclusion of a range of species. • Risk maps integrating data of where samples of *C. fleckeri* and *C. barnesi* have been collected and where appropriate integrating local conditions such as freshwater input (with appropriate attribution to MTSRF funding). • Progress update on development of risk maps: data being integrated, process for development of maps etc. • Article for MTSRF Program newsletter	30 Mar 2010	$20,000
Total MTSRF Funding		**$50,000**

Project Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$50,000	-	$50,000
JCU		$30,000	$30,000
AIMS	-	$15,000	$15,000
Total	**$50,000**	**$45,000**	**$95,000**

JCU Project 4.8.7 Budget 2009/10

Item	MTSRF Funds	In-kind	Total Cost
Salaries	-	$45,000	$45,000
Operating	$45,000	-	$45,000
Travel	$5,000	-	$5,000
Communication / Extension[1]	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$50,000**	**$45,000**	**$95,000**

[1] Funds have been allocated to the generic communication/extension activities for the Sustainable Use and Management Program. This is to be managed under Theme 5.

PROGRAM 8: SUSTAINABLE USE AND MANAGEMENT OF MARINE RESOURCES OF THE GREAT BARRIER REEF

Project 4.8.8: To Be Brokered – James Cook University

PROGRAM 9
SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Program Leader and Host Organisation

Professor Steve Turton, James Cook University (JCU)

Program 9 Budget Summary

	Cash	In-kind	Total
MTSRF	$1,203,275	-	$1,203,275
Other	$246,450	$1,353,377	$1,599,827
Total	**$1,449,725**	**$1,353,377**	**$2,803,102**

The program is focused on sustainable use, planning and management of environmental assets of North Queensland's tropical rainforests and adjacent Wet Tropics production and urban landscapes that constitute significant catchment areas for the Great Barrier Reef. The approach is to consider these landscapes as linked social, ecological and economic systems. The main objective is to provide the knowledge base that supports the management of the Wet Tropics World Heritage Area, as well as supporting sustainable economic activities (notably agriculture, agroforestry, tourism and Indigenous enterprises), while enhancing biodiversity and maintaining essential ecosystem services across the entire Wet Tropics landscape.

This is a large program that hosts seven project areas that align directly with research needs for DEW, WTMA, Terrain NRM , Indigenous groups, industry and other key stakeholders based in the Wet Tropics bioregion and NRM region:

Project 4.9.7, focussing on strategic natural resource management, is shared with Program 2 (Theme 1). This fulfils an integrative function across both programs, and will articulate with Theme 5 – Enhancing Delivery. Within the program the conduct of participatory case studies will continue with end users and communities, for their benefit, complementing each of the other project areas (e.g. land use planning, Indigenous, forests, restoration). Within Program 2 it will build on the development of a framework and tools for status and trend reporting, to match directions established in collaboration with end users through Theme 5. Baseline data and data management services continue to be provided by the Status and Trends, Threatened Species, Invasive Species programs to avoid duplication. Program 9 also provides strong links with the MTSRF Terrestrial Climate Change and Water Quality Programs and Data Integration and Synthesis processes across the MTSRF.

The research outputs will include:

- Development of mechanisms to enhance institutional and planning arrangements to underpin biodiversity, water quality and wider ecosystem services in the GBR Region whilst maintaining viable regional communities.
- Valuation of residential contribution to biodiversity and ecosystem services in regional and local planning areas e.g. Daintree as the first site.
- Identification of biodiversity values and metrics for incorporation into regional and local planning mechanisms.

- Analysis of incentive mechanisms available for the management of ecosystem services in urbanising environments in North Queensland.
- Assessment of the impacts of community infrastructure on the Wet Tropics WHA and surrounding ecosystems and develop methodologies to mitigate the impacts.
- Mapping of riparian vegetation quality and habitat connectivity in urban and rural areas of North Queensland.
- Identification of major issues relating to tourist motives and behaviours for visiting the Wet Tropics.
- Determination of key trends and economic contribution of Wet tropics tourism to North Queensland.
- Determination of impacts of tourism in the Wet Tropics WHA and mitigation strategies for adverse impacts.
- Identification of community perceptions and knowledge of use and management of the Wet Tropics.
- Development of toolkit and indicators for monitoring and evaluating reforestation success.
- Development of methods to optimise reforestation success.
- Development of an optimisation model for regional investment in reforestation and management.
- Assess Indigenous nature resource use within the Wet Tropics World Heritage Area.
- Optimise traditional owner knowledge and engagement in natural resource management particularly water resources and changes to water quality and resulting ecological impacts.
- Development of tools and mechanisms to integrate the learnings across the program to enhance the information delivered to major natural resource management agencies and the community.

Projects

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.1: Indigenous Landscapes of the World Heritage Area

Project Leader and Host Organisation

Professor Steve Turton (Acting), James Cook University (JCU)

Project Team 2009/10

Title	Organisation	Role	FTE
Prof Steve Turton	JCU	Researcher, all objectives	0.20
Linda Leftwich (Aboriginal Research officer)	JCU	Researcher, all objectives	1.0
Traditional Owners of the WTWHA	Various	Researchers and users, all objectives	0.3
Rainforest Aboriginal Advisory Committee	WTMA	Researchers and users, all objectives	0.1
Mr Phillip Rist	Girringun Aboriginal Corporation	Researcher and user, all objectives	0.1
Dr Allan Dale	Terrain	Research user, all objectives	0.1
Dr Rosemary Hill	CSIRO	Researcher, all objectives	0.05
Dr. Leanne Cullen	CSIRO	Researcher, all objective	0.2

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Andrew Maclean
Alliance for Sustainable Tourism	Annie Riddet
Terrain NRM	Allan Dale
QEPA	TBA

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

- To understand Indigenous natural resource use within the Wet Tropics WHA through the completion of reviews and comparative assessments.
- To optimise Traditional Owner engagement and knowledge in natural resource management.
- To enhance opportunities for building capacity in Traditional Owner groups for engagement in research and management of the Wet Tropics WHA.

Project / Task Methodology

Governance and Institutional Linkages

Governance arrangements established for the project have ensured that the research remains responsive to Traditional Owner's directions despite the closing of the Aboriginal Rainforest Council (ARC). Processes to consider an independent representative Rainforest Aboriginal organisation or organisations to replace the role of ARC are ongoing, facilitated by the WTMA. Meetings are continuing between members of the Project Team researchers, end-users and Traditional Owners including JCU, CSIRO, WTMA, Terrain, Jabalbina, North Queensland Land Council, Girringun, Bana Yaralji Bubu Incorporated and others.

Staff Developments

Professor Steve Turton will remain project leader for the duration of the 2009/10 funding period. All other staff are continuing to work in the project.

Forward Planning for 2009/10

It was agreed in 2008/09 that MTSRF objectives would be realised primarily through detailed case studies covering various topics (outlined below). Findings again will be reported to national and international stakeholders through conference participation and publication of reports and papers. Regional workshops will be used to deliver information to Indigenous end users and the proposed case studies will provide detailed accounts of how Rainforest Aborigines have interpreted information and events relevant to the selected topics and whether they have found it useful (or otherwise) to their engagement with management.

Project Outputs/Outcomes

1) ***Development of protocols and metrics associated with 'cultural indicators' for the WTWHA:*** Discussions with Traditional Owners and a regional (Wet Tropics) case study, concerning the development of protocols and metrics associated with 'cultural indicators' for the Wet Tropics World Heritage Area will help fulfil reporting required by the World Heritage Convention and by the Regional NRM Plan. Findings will be presented to management agencies involved in the WTWHA, with data and research/monitoring protocols held by communities involved and used by Aboriginal Co-researchers from community level case studies.
2) ***Traditional Owner engagement and knowledge in natural resource management.*** The focus on enhancing wet tropics engagement to international best-practice will continue through building on the desk-top global analysis in ARP1 and 2, with capacity building in international and local workshops in 08-09. Targeted research and development identified from those workshops will continue in 09-10. Wet Tropics Traditional Owners involved in this MTSRF project, with additional support from WTMA and The Christensen Fund, participated in a workshop on Indigenous Cultural Action for Biological and Cultural Conservation and Human Well-Being at the World Conservation Congress in Barcelona, in October 2008 which resulted in both an international network and a set of recommended practical steps. The outcomes from the World Conservation Congress will be shared with Traditional Owners of the Wet Tropics and management agencies at a workshop in May 2009. A report on the outcomes of this workshop will contribute to a synthesis of the Indigenous natural resource management science from the project.
3) ***Our Turn Now: Bama and Murrai Women Telling Their Stories Relating to the Rainforest – Plants, Foods and Their Processing:*** A research project involving Bama and Murri women as co-researchers commenced in September, 2008. This project is planned in two (2) stages over two (2) years and will include women from Yarrabah, linguistic groups in the Girringun area, Kuku Yalanji and a linguistic group on the Atherton Tablelands and will be an opportunity to build the capacity of Traditional Owner

women to become researchers themselves by engaging them in this project as co-researchers. It will also be an opportunity to understand their use of natural resources within the Wet Tropics World Heritage area. The significance of the research stems from a comment made by Leigh Pentecost (2008), of Girringun Aboriginal Corporation, Cardwell "…you don't hear the women's voices and their stories". Consequently, the aim of the research is to collect Bama and Murri women's stories that relate to the Wet Tropics World Heritage Area, in particular, stories and information about foods and plants and the processing of particular plants and foods. There are gaps in literature in relation to food processing in the Wet Tropics area and it is hoped this study will add significantly to whatever literature is available and will link to, or will be complementary to, National and World Heritage listing processes.

2009/10 Project Activities

The table on the following page outlines the proposed targeted activities for the next year. The proposed activities largely emerge from the findings of the project's activities in the year 2006-2009.

Research End Users

The Rainforest Aboriginal Advisory Committee (RAAC), including the same *elected* representatives as the ARC, continues to play an important role in providing advice and as a decision making body for matters concerning land and cultural heritage management in the Wet Tropics World Heritage Area. Our end users will continue to be Girringun, RAAC, the Rainforest Aboriginal people of the WTWHA, Aboriginal Councils, NTRBs, WTMA, Terrain, DEWHA and other government funded bodies involved in the management of the WTWHA.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
a	Completion of first two community case studies and identification of a third case study to determine community and regional cultural indicators for the Wet Tropics World Heritage Area (Leanne Cullen)	31 Oct 2009
b	Report on the workshop conducted with Traditional Owners and management agencies to enable capacity-building in the wet tropics from the findings and networks established at the International Alliance session co-hosted at the World Conservation Congress in October 2008.(Ro Hill)	31 Oct 2009
c	Completion of collection of "Our Turn Now" stories by Bama and Murrai women. (Linda Leftwich)	31 Oct 2009
a	Collation of data on cultural values associated with the Wet Tropics World Heritage Area useful to parties implementing the Wet Tropics Regional Agreement and the Aboriginal Natural and Cultural Resource Management Plan	27 Feb 2010
b	Synthesis of contribution to Traditional Owner natural resource management science from the Indigenous landscapes project (Ro Hill)	27 Feb 2010
c	Analysis of the Bama and Murrai women's stories. (Linda Leftwich)	27 Feb 2010
a	Workshop to discuss and fine tune regional scale Wet Tropics cultural indicators and reporting requirements. Identify and arrange to collect final and mutually agreed set of indicator data most useful to parties implementing the wet Tropics Regional Agreement and the Aboriginal Natural and Cultural Resource Management Plan, and to Aboriginal case study communities.	31 May 2010
b	Traditional Owner natural resource management science synthesis communicated to international science audience and regional and national community, industry and government stakeholders. (Ro Hill)	31 May 2010
c	On going research in Yarrabah and Girringun area from November 2009 to February 2010. (Linda Leftwich)	31 May 2010
a	Finalise a world class output effectively describing the cultural heritage values of the wet Tropics World Heritage Area (Leanne Cullen)	June 2010
b	Engagement of Traditional Owners into activities and projects based on international best-practice between WTWHA managers and Traditional Owners	June 2010
c	Publication of the Bama and Murrai women's stories to appropriate audiences. (Linda Leftwich)	June 2010

Project 4.9.1 Milestone Payments 2009/10

For 2009/10 outputs only	Date	JCU	MTSRF
Milestones		**JCU**	**JCU**
• Signing of Contract		$24,000	$24,500
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Progress Report on: (activity a^1): Completion of community case studies on cultural indicators (activity b^1): Wet tropics workshop to share Barcelona outcomes with Traditional Owners and management agencies (activity c^1) : Recording of bama and murria women's stories; • Copies of papers, reports, and publications produced up to this date, in relation to the above identified project activities (with attribution of MTSRF funding to all documentation)	15 Nov 2009	-	-
Report 2 (oral submission to Operations Committee): • Progress Report on: (activity a^2): Cultural data in context of cultural indicators case studies (activity b^2): Synthesis of contribution to Traditional Owner natural resource management science from the project (activity c^1) : Analysis of bama and murria women's stories • Copies of papers, reports, and publications produced up to this date, in relation to the above identified project activities.	15 Feb 2010	$23,000	$24,500
Report 3 submission: • Final Report on: (activity a^3): Report on best practice and use of methods for the development of a series of cultural indicators for the wet tropics. (activity b^3): Report on the contribution to Traditional Owner natural resource management science (activity c^3): Publication of bama and murrain women's stories • Copies of papers, reports, and publications produced up to this date, in relation to the above identified project activities • Final Summary of all Project Activities, Communications and Outputs undertaken in the course of year to 16 June 2008	3 June 2009	$23,000	$24,500
Total Funding		**$70,000**	**$73,500**

Project 4.9.1 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	MTSRF	Cash	In-kind	Total
MTSRF	$73,500	-	-	$73,500
Visual Documentation	$1,500	-	-	$1,500
JCU	-	$70,000	$80,000	$150,000
Girringun	-	-	$5,000	$5,000
Terrain	-	-	$15,000	$15,000
CSIRO	-	-	$20,000	$20,000
Total	**$75,000**	**$70,000**	**$120,000**	**$265,000**

* A total of $1,500 is held by the RRRC for Visual Documentation for this project (see Theme 5).

JCU Project 4.9.1 Budget 2009/10

Item	MTSRF Funds	JCU Cash	In-kind	Total Cost
Salaries	$47,000	*$70,000	$90,000	$207,000
Operating	$11,000	-	-	$11,000
Travel	$8,000	-	-	$8,000
Communication / Extension	$7,500	-	$20,000	$27,500
Capital	-	-	-	-
Institutional overheads	-	-	$10,000	$10,000
Total	**$73,500**	**$70,000**	**$120,000**	**$263,500**

* Cash contribution from JCU towards Snr Indigenous Research officer's salary.

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.2: Sustainable nature based tourism: Planning and management

Project Leader and Host Organisation

Professor Bruce Prideaux, James Cook University (JCU)

Project Team

Title	Organisation	Role	FTE
Professor Bruce Prideaux	JCU	Project Leader, researcher in objectives (a) (b)	0.2
Adj. Prof. Glenn Ross	JCU	Researcher, objective (a)	0.1
Dr Heather Zeppel	JCU	Researcher, objectives (a)	0.1
Prof. Steve Turton	JCU/CSIRO	Researcher, objective (b)	0.1
Dr Karen McNamara	JCU	Post Doc Researcher, objective (a)	1.0
Dr Julie Carmody	JCU	Post Doc Researcher, objective (b)	1.0
Max Chappell	WTMA	Liaison, user, objectives (a) (b)	0.1
Lisa King (PhD student)	JCU	Research, objective (a)	1.0

This Project will benefit from the capacity building component of Theme 5 Enhancing Delivery.

Summary Table of Research Users 2008/2009

Organisation	Organisational Contact
WTMA	Max Chappell
Terrain NRM Ltd	Allan Dale
QEPA	TBA
Alliance for Sustainable Tourism	Annie Riddet
TTNQ	Annie Riddet

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

This project will develop an improved understanding of the perceptions and motivations of tourists and local community, members who use the Wet Tropics rainforests, allow identification of major drivers and trends in visitation, develop a visitor barometer, report on benchmarking of tourism patterns and development of tools to assist sustainable visitor management. Understanding trends and drivers will enable WTMA and the tourism industry to develop internationally competitive visitor experiences and enable WTMA to develop more effective visitor management policies. A Rapid Assessment Capability built into the visitor survey will allow stakeholders to understand the implications of unexpected events and assist in allowing them to respond to such events in an informed and effective manner.

The major outputs of the second component will enable WMTA to: understand visitor behaviour at site level, identify changes in community perceptions towards the Wet Tropics and understand commercial tour operators concerns and perceptions. This information will enable more effective management at site level, provide information that will assist in selection of alternative sites and better understand changes in community perceptions. The task will provide commercial tour operators with data on the sustainability of various attractions.

Key Objectives

(a) Report on the sustainable use of rainforest resources by the tourism industry.

(b) Monitoring of visitors at site level and determining community perceptions.

Project / Task Methodology

Objective (a): To report on the sustainable use of rainforest resources by the tourism industry

To establish a Wet Tropics wide system for tourist monitoring, a range of industry tourism data will be collected. This data will be used as the input to a report on a range of tourist related issues identified by end users. Tourists display a wide range of behaviours and characteristics including; significant variations in their motivations for visiting the Wet Tropics, their expectations of their visit, their expenditure patterns and usage patterns of facilities. To identify these characteristics this project has developed a Wet Tropics wide tourist meta data set that will facilitate long term analysis of tourist patterns as well as collect a range of economic data. The data output will enable detailed knowledge of tourist segment characteristics; use patterns over time, expenditure patterns, motivations, satisfaction etc to be developed. For research users this data will provide regular updates on tourist patterns and behaviours. The data will also be essential for identification of the key patterns of tourist use, to identify changes in tourist use and the reason for those changes; to identify the economic contribution of the Wet Tropics to the regional economy and identify issues related to sustainability at the micro and macro levels. The data is also critical for the development of management tools and frameworks as well as the identification of tourism impact parameters (building on work undertaken by the Rainforest CRC[17]) that will ensure long-term sustainability of key Wet Tropics sites and measurement against state, national and international benchmarks.

To gather the data a long term monitoring program based on up to six survey sites (including sites in the forest as well as outside) has been developed and data is collected monthly. The survey instrument is flexible enough to gather long-term tourist data as well as introduce new items to explore issues and trends identified during the course of ongoing data collection. The Task has included a part PhD scholarship co-funded with Sustainable Tourism CRC.

(i) **Identify major issues relating to tourist motivations and behaviours for visiting the Wet Tropics:** Tourist patterns and motivations have been identified and published as a barometer on a quarterly and annual basIsland Data collected through the tourist survey will identify the importance of specific attractors in the rainforest experience, the importance of specific sites as triggers to attract tourists, and identify key elements of the experience that determine satisfaction levels. Findings will support Project 4.9.2b.

(ii) **Identify key trends and drivers of Wet Tropics visitor patterns:** Trends will be identified on a year-to-year basis using a number of indicators developed from ongoing surveying. These will be compared to state and national trends for comparison and

[17] Wilson, R. F., Turton, S. M., Bentrupperbaumer, J. M. and Reser, J. P. (2004) *Visitor Monitoring System for the Wet Tropics World Heritage Area, Volume 1 Procedural Manual.* Rainforest CRC, Cairns.

benchmarking. Drivers are sometimes difficult to determine and this part of the research will commence with a literature survey followed with a series of targeted items within the ongoing survey. The economic contribution of tourism will also be assessed building on work undertaken for the CRC Rainforest. At the conclusion of the project a synthesis report will be prepared to identify trends, segments and identify major issues that require further research.

(iii) **Develop a rapid assessment capability:** This capability will allow a rapid assessment to be made of major issues and threats that may emerge in the future. For example, such a capacity if available now would allow assessment of visitor reaction to events such as Cyclone Larry. This capability has been built into the monitoring system in Objective a(i).

(iv) **Develop Management tools:** Management tools and frameworks including environmental impact parameters will be developed to assist maintain long term sustainability of key Wet Tropics sites.

Objective (b): Monitoring of visitors at site level and community perceptions

Tools developed for monitoring visitor attitudes and perceptions at site level under the CRC Rainforest program will be revised where necessary and a follow-on survey conducted to reassess visitor and community attitudes.

(i) **Identify community attitudes, knowledge and perceptions of use and management of the Wet Tropics:** This project was completed in Novemebr 2008. This objective involved a major survey conducted as a follow-on of the previous site survey funded by the CRC Rainforest[1] and identified changes that have occurred in visitor usage and perceptions in the period since the last survey.

(ii) **Develop a best practice strategy for creating a Wet Tropics wide integrated rainforest experience theme for visitors.** This component of the project will build on existing data as well as new data to develop whole of Wet Tropics visitor strategy to develop and test coherent themes to attract visitors to the park and to differentiate the park from other ecotourism areas. The project will build on survey data from Objective a(i) and Task b(i) to develop a best practice strategy. Specific outputs will include: a theme based approach to tourism; and tour operator guides that will assist towards future production of a WTWHA tour operator accreditation system.

Project Outputs / Milestones

Objective	Targeted Activity	Completion Date
a	Continue visitor monitoring program for the Wet Tropics WHA. *Objectives a(i), (iii) and (iv)*	Ongoing to June 2010
a	Identify key drivers of Wet Tropics visitor patterns including economic contribution. *Objective a(ii)*	Ongoing to June 2010
b	Produce tour guide handbook as part of the establishment of a best practice strategy for sustainable nature-based tourism in the Wet Tropics WHA. *Objective b(ii)*	November 2009
b	Understand and identify levels of visitor use and perceptions of WT sites *Objective b (i)*	June 2010

Project 4.9.2 Milestone Payments 2009/10

Milestones	Date	MTSRF	WTMA	RRRC
		JCU	JCU	JCU
Signing of contract		$80,000	$5,000	$5,000
• Project Leader to attend Operations Committee Meetings (3-4 meetings per year).	2009/10	-	-	-
Report 1 submission: • Submission of quarterly visitor barometers (#1,09; #2,09; #3,09) (A) [JCU] • Progress Report on Wet Tropics visitor site level surveys (Bi) [JCU] • Finalise and submit text for Tour Guide Handbook to WTMA with a copy to RRRC (WTMA will typeset and publish the guide) (Bii) [JCU] • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable [JCU]	1 Nov 2009	$80,000	-	-
Report 2 submission: • Submission of quarterly visitor barometer (#4,09) (A) [JCU] • Progress Report on Wet Tropics visitor site level surveys (Bi) [JCU] • Progress report on rainforest tourism symposium [JCU] • Report on operation and structure of the tourism industry in WTWHA [JCU] • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable [JCU]	15 Feb 2010	$28,500	-	-
Report 3 submission: • Submission of quarterly visitor barometers (#1,10; #2, 10) (A) [JCU] • Final Rainforest Tourism Report inc third annual report) (A) [JCU] This report will contain a synthesis of research findings for the life of the project • Final Airport Exit Survey Report inc third annual report (A) [JCU] This report will contain a synthesis of research findings for the life of the project • Report on Management tools and frameworks (Aiv) [JCU] • Final Technical Report on Wet Tropics visitor site level surveys (Bi) [JCU] • Report on the stakeholder workshop to explain visitor monitoring program [JCU] • Final summary of communication activities undertaken through the course of Year 4 of project [JCU] (Each report must include appropriate attribution of MTSRF funding)	1 Jun 2010	$10,000	-	-
Total MTSRF Funding		**$198,500**	**$5,000**	**$5,000**

Project 4.9.2 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$198,500	-	$198,500
MTSRF Visual Documentation*	$1,500	-	$1,500
JCU	-	$35,000	$35,000
WTMA	$5,000	$10,000	$15,000
RRRC	$5,000		$5,000
Sustainable Tourism CRC (0.5 PhD Scholarship)#	-	$10,000	$10,000
Total	**$210,000**	**$55,000**	**$265,000**

* A total of $1,500 is held by the RRRC for Visual Documentation for this project (see Theme 5).

\# Linked with Objective (a).

JCU Project 4.9.2 Budget 2009/10

Item	MTSRF	WTMA	RRRC	JCU In-kind	Total Cost
Salaries	$165,000	$5,000	$5,000	$55,000	$230,000
MTSRF Visual Documentation	$1,500	-	-	-	$1,500
Operating	$15,000	-	-	-	$15,000
Travel	$15,000	-	-	-	$15,000
Communication / Extension	$3,500	-	-	-	$3,500
Capital	-	-	-	-	-
Institutional overheads	-	-	-	-	-
Total	**$200,000**	**$5,000**	**$5,000**	**$55,000**	**$265,000**

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.3: Impacts of urbanisation on North Queensland environments: management and remediation

Project Leader and Host Organisation

Professor Steve Turton, James Cook University (JCU)

Project Team 2009/10

Title	Organisation	Role	FTE
Prof Steve Turton	JCU/CSIRO	Program and Project Leader, researcher, objectives (a) (b) (c)	0.50
Dr Miriam Goosem	JCU	Researcher, ecology, objectives (a) (b) (c)	1.00
Dr Iris Bohnet	CSIRO	Researcher, landscape planning, social-sciences, objectives (b) (c)	0.17
Ms Pam Schultz (PhD student)	CSIRO/JCU	Researcher, social sciences, NRM, objective (c)	1.00
Pertina Pert	CSIRO	Spatial Analysis Support	0.03
Mr Max Chappell	WTMA	User, PA manager, objectives (a) (b) (c)	0.05
Dr Steve Goosem	WTMA	User, PA manager, objectives (a) (b) (c)	0.05
Environmental officers	Powerlink	User, utilities, objective (a)	0.05
Environmental officer	QDMR	User, planner, objective (a) (c)	0.05
Project support/ logistics officer	QDMR	Technical, engineer, objective (a)	0.05
Dr Allan Dale	Terrain NRM	User, objectives (b) (c)	0.05
Ms Ally Lankester	JCU	MTSRF Program 7	1.00
Ms Michelle Esparon	JCU	MSTRF Project 4.9.2	1.00

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
WTMA	Steve Goosem
Terrain NRM Ltd	Rowena Grace
EPA	Andrew Millerd
Alliance for Sustainable Tourism	Annie Riddett
QDMR	Karen Oakley
QDMR	Alison Burgoyne
Powerlink	Stephen Martin
Queensland Canegrowers	Matt Kealley

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This project aims to develop increased understanding of impacts of rapid urban, peri-urban and rural development on wet tropics ecosystems and linked socio-economic systems, together with mitigation strategies for minimising or reversing adverse trends. Our projects are linked with terrestrial components of Programs 6 (Threatening Processes and Invasive Species) and 7 (Water Quality), and with Projects 4.9.5 (Restoring Tropical Forest Landscapes) and 4.9.6 (Strategic Natural Resource Management and Land Use Planning) within Program 9. These links will feed into the Integrated Report Card process.

Key Objectives:

(a) Linear community infrastructure: impacts and mitigation.

(b) Riparian and remnant vegetation: Modelling of quality and habitat connectivity in urban and rural areas.

(c) Landscape values: defining landscape character, impact of urbanisation, and management and remediation through case studies.

Project / Task Methodology

Objective (a): Linear community infrastructure: impacts and mitigation

This objective has several key tasks:

- In collaboration with stakeholders, establish feasible best-practice designs to maximise ecological connectivity and minimise impacts of linear community infrastructure in rainforests, adjoining habitats and urbanising landscapes of the Wet Tropics bioregion.
- Identify informative and cost-effective ecological indicators of linear infrastructure impacts in rainforests and adjoining habitats in the Wet Tropics bioregion.
- Consider effectiveness of mitigation strategies in restoring ecological processes and function in the vicinity of linear community infrastructure (linked to Project 4.9.5) and in reducing impacts of infrastructure on threatened, rare and endemic species.
- Examine the use of high-resolution remotely sensed data to assess habitat condition adjacent to linear community infrastructure.

Methods used for this task involve assessment of impacts by field survey of biophysical attributes using replicated sites on linear clearings situated in the same habitat type, satellite and aerial photographic remote sensing and establishment of easily assessed cost-effective indicators of these impacts.

Mitigatory strategies that have continued to be assessed and/or trialled and monitored for effectiveness include fencing, road underpasses and canopy bridges, traffic calming strategies and experimental revegetation across powerline clearings.

Objective (b): Riparian and remnant vegetation: Modelling of quality and habitat connectivity in urban and rural areas

This objective has the following key tasks:

- Test and apply riparian vegetation quality indicators that are quickly and easily assessed using remote sensing and GIS modelling that were successfully established in recent research in the Douglas Shire to riparian and remnant vegetation in major urbanising landscapes in sea- and tree-change areas of the Wet Tropics bioregion (linked to IRC). Sites are to be selected in collaboration with stakeholders, together with allied MTSRF projects.
- Test vegetation quality as a surrogate for faunal habitat quality using indicators of faunal habitat connectivity.

- Create GIS models and a priority classification of riparian and remnant vegetation in these areas for conservation or restoration in terms of maintaining or creating faunal habitat connectivity (linked with Projects 4.9.6 and 1.4.3).

Remote sensing via aerial and/or satellite photographic analysis forms the basis of this project to determine canopy cover and width/area of riparian and remnant vegetation and from this determine a quality ranking. This quality is tested at randomly-chosen but stratified field sampling sites and further examined in terms of faunal habitat quality using targeted faunal indicators such as guilds of birds and/or particular species of conservation concern. GIS models constructed from this data are used to examine gaps in connectivity or low quality areas which can then be prioritised in terms of importance of gap in provision of connectivity in the landscape and by feasibility of restoration. Field investigation and photographic records can be incorporated into free software GIS models or more complex GIS system models of priorities on aerial photograph or topographic backgrounds to allow easy identification of site and priority by stakeholders.

Objective (c): Sea- and tree-change landscapes: impacts of urbanisation and mitigation potential

This objective has several key tasks:

- Identify sea- and tree-change phenomena among the Australian community including a historical analysis of landscape change in field/case studies in North Queensland using social science and landscape planning methods.
- Identify environmental, recreational, scenic and other values in selected sea- and tree-change landscapes in the wet tropics bioregion.
- Develop practical recommendations for local government and NRM authorities on how to manage and remediate the impacts of urbanisation.

This sub-project aims to gain a better understanding of who the people are, and how or why they choose particular areas of North Queensland to live or invest in and what the potential landscape and environmental impacts of urbanisation, peri-urban and rural development are and how to best manage and remediate these impacts.

Methods used involve a literature review of the phenomena of sea- and tree-change in Australia. In collaboration with the MTSRF Project 4.9.6 team and Terrain NRM Ltd sea- and tree-change case study landscapes were selected. Case studies include historical analyses of land use change and urbanisation patterns and qualitative interviews with residents and ‘newcomers’ to these landscapes, which inform the analysis of environmental, recreational, scenic and other landscape values. Stakeholder workshops are also used to inform the development of practical recommendations for local government and NRM authorities on how to manage and remediate the impacts of urbanisation. The project works in close collaboration with MTSRF Project 4.9.6.

Project Outputs/Outcomes

Objective	Targeted Activity	Completion Date
a	Refinement of best practice designs to maximise ecological connectivity and minimise impacts of linear community infrastructure in rainforests and adjoining habitats of Wet Tropics WHA	June 2010
a	Identification of informative and cost-effective ecological indicators of linear infrastructure impacts in rainforests and adjoining habitats in the Wet Tropics bioregion	June 2009
a	Continuing consideration of effectiveness of mitigation strategies in restoring ecological processes and function in the vicinity of linear community infrastructure (linked to Project 4.9.5), and reducing impacts on threatened, rare and endemic species, subject to further funding from QDMR	June 2010*
b	Ongoing testing and application of riparian and remnant vegetation quality indicators. Field-truthing for Mission Beach case study area.	June 2009
b	Identification of priority areas for conservation, including maintenance of landscape connectivity for Mission Beach area. Field-truthing of priority areas.	Dec 2009
b	Remote sensing and GIS modelling of recovery of vegetation two to three years after Cyclone Larry for Mission Beach case study area.	June 2010
b	Delivery of field-truthed mapping of Mission Beach area into Project 4.9.5 habitat models of the region	June 2010
c	Assessment of landscape values in sea- and tree- change landscapes	June 2010
c	Assessment of the impacts of urbanisation on sea- and tree-change landscapes	June 2010
c	Practical recommendations for local government and NRM authorities on managing and remediating impacts of urbanisation	June 2010

* Co-funded by QDMR.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
	• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10
a, b, c a b c	**Report 1 submission:** • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable. • Progress report regarding effectiveness of overpasses, subject to renewed QDMR funding of underpass and overpass monitoring • Progress report for Mission Beach area on activities associated with objective b: Remote sensing and GIS analyses of riparian and remnant vegetation quality indicators • Progress update on activities associated with objective c. Responsible: Dr Iris Bohnet [CSIRO]: Summary of communication activities, number of interviews carried out in case study areas that inform analysis of landscape values	15 November 2009
b c a,b,c	**Report 2 submission:** • Final report with attribution of MTSRF funding on testing and application of riparian and remnant vegetation quality indicators for Mission Beach study area of imagery 2-3 years post-cyclone Larry using remote sensing, GIS modeling • Report associated with objective c. Responsible: Dr Iris Bohnet [CSIRO]: Assessment of landscape values in sea- and tree- change landscapes, Assessment of the impacts of urbanisation on sea- and tree-change landscapes, Practical recommendations for local government and NRM authorities on managing and remediating impacts of urbanisation. • Final summary of communication activities undertaken through the course of Year 3 of project.	1 June 2010
b a	Verbal progress report to Operations Committee and Information transfer between agencies on: • Provision of Project 4.9.3 data to Project 4.9.5 MTSRF mapping and planning project for Mission Beach • Provision of Project 4.9.3 data to QDMR on linear infrastructure mitigation in the wet tropics region. Responsible officer: Dr Miriam Goosem (JCU).	1 June 2010

Project 4.9.3 Milestone Payments 2009/10

For 2009/10 outputs only Milestones	Date	MTSRF JCU	MTSRF CSIRO	JCU JCU
• Signing of contract.		$45,000		$60,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-
Report 1 submission: • Summary of any communication activities undertaken to date, including minutes of meetings/workshops if applicable. • Progress report regarding effectiveness of overpasses, subject to renewed QDMR funding of underpass and overpass monitoring • Progress report for Mission Beach area on activities associated with objective b: Remote sensing and GIS analyses of riparian and remnant vegetation quality indicators • Progress update on activities associated with objective c. Responsible: Dr Iris Bohnet [CSIRO]: Summary of communication activities, number of interviews carried out in case study areas that inform analysis of landscape values	15 Nov 2009	$71,750	$10,000	
Report 2 submission: • Final report with attribution of MTSRF funding on testing and application of riparian and remnant vegetation quality indicators for Mission Beach study area of imagery 2-3 years post-cyclone Larry using remote sensing, GIS modeling • Report associated with objective c. Responsible: Dr Iris Bohnet [CSIRO]: Assessment of landscape values in sea- and tree- change landscapes, Assessment of the impacts of urbanisation on sea- and tree-change landscapes, Practical recommendations for local government and NRM authorities on managing and remediating impacts of urbanisation. • Final summary of communication activities undertaken through the course of Year 3 of project.	1 June 2010	$71,750	$15,000	
Total MTSRF Funding		**$188,500**	**$25,000**	**$60,000**

Project 4.9.3 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$213,500	-	$213,500
MTSRF Visual Documentation*	$1,500	-	$1,500
James Cook University	$60,000	$81,237	$141,237
CSIRO	-	$19,034	$19,034
WTMA	-	$15,000	$15,000
Terrain NRM Ltd	-	$7,400	$7,400
QDMR	-	$7,400	$7,400
Total	**$275,000**	**$130,071**	**$405,071**

* A total of $1,500 is held by the RRRC for Visual Documentation for this project (see Theme 5).

JCU Project 4.9.3 Budget 2009/10

Item	MTSRF	JCU Cash	JCU In-kind	External In-kind (WTMA, Terrain NRM, QDMR)	Total Cost
Salaries	$155,000	$60,000	$81,237	$29,800	$326,037
Operating	$28,500	-	-	-	$28,500
Travel	-	-	-	-	-
Communication / Extension	$5,000	-	-	-	$5,000
Capital	-	-	-	-	-
Institutional overheads	-	-	-	-	-
Total	**$188,500**	**$60,000**	**$81,237**	**$29,800**	**$359,537**

CSIRO Project 4.9.3 Budget 2009/10

Item	MTSRF	CSIRO – In Kind	Total Cost
Salaries	$18,535	-	$18,535
Operating	$5,321	-	$5,321
Travel	$1,144	-	$1,144
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$19,034	$19,034
Total	**$25,000**	**$19,034**	**$44,034**

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.4: Integrating ecology, economics and people in forest and landscapes

Project Leaders and Host Organisation

Dr Nick Emtage and Assoc. Professor John Herbohn,
School of Integrative Systems, The University of Queensland

Project Team 2009/10

Title	Organisation	Role	FTE
Nick Emtage	UQ	Project leader	1
John Herbohn	UQ	Project leader	0.1
Krishna Shrestha	Syd. Uni	Project researcher	0.05
Prof Jerry Vanclay	SCU	Project Researcher – forest ecology and ecological modeling. Objective b	0.05
Assoc. Prof Steve Harrison	UQ	Project Researcher, Economist, Objectives a, b	0.05
Carl Smith	UQ	Project researcher	0.05
Vu Duc Nang	UQ	PhD candidate	1

This Project will benefit from the capacity building component of Theme 5 Enhancing Delivery.

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
Terrain	Karen Vella: also Alan Dale, John Reghenzani, Fiona Barron, Moni Carlisle, Penny Scott and Neil Sing
GBRMPA	Karen Lawrence
Queensland Canegrowers	Matt Kealley
WTMA	Campbell Clark
DEWHA	Kevin Gale, Fiona McQueenie, Mikaela Griffith, Peter Mathews

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

Key Objectives:

(a) Produce a comprehensive set of profiles (typology) of landholders in relation to NRM practices on private land in the Wet Tropics region that will facilitate effective design and delivery of NRM and rural development programs by public agencies.

(b) Develop tools to assist landholders, managers and researchers in decision making about investments in forest restoration and to help identify the resulting economic, social and environmental benefits.

Project / Task Methodology

Objective (a): Study of the small-acreage rural landholders' adoption of CRP's and use of NRM programs with a particular focus on vegetation management in the Sunshine Coast and Wet Tropics regions of Queensland

This study of hobby and lifestyle landholders' vegetation management aspirations, practices, desired assistance and relationship to regional revegetation priorities has been identified by Terrain as a priority following the outcomes of the rural landholders' survey undertaken earlier in the project. The responses to that survey and subsequent analyses highlighted that a significant proportion of 'hobby farmers' and 'lifestyle' residents in rural areas are not engaged with land management agencies. Extensive literature reviews have revealed that this group of rural landholders is little researched or understood by NRM policy makers in Australia or overseas, yet they are becoming a more prominent sector in the rural landscape, particularly after the 'sea-change' and 'tree-change' phenomena (Meadows and Emtage in prep.). The research will use a series of case studies to identify these landholders' vegetation management aspirations, the costs and benefits they perceive, there current use of information and extension services and the types of assistance or incentives they would find useful. The research will adapt the current PhD research methodology being undertaken by John Meadows in the Sunshine Coast which is already in an advanced state of preparation. The literature review of the topic has been completed, the case study design framework has been developed, the interview schedule has been drafted and approved by the University of Queensland Ethics review committee and field work could commence in mid-2009, allowing time to analyse the data and write-up the study within the time frame of the ARP4.

Objective (b): Development of growth equations for native tree species

Building on the previous research to incorporate information about the ecological attributes of species used in revegetation programs from expert surveys, we will continue development of improved growth models for native species used in reforestation situations based on previous growth models developed for North Queensland rainforests by Jerry Vanclay. A PhD candidate, Mr Nang, has completed his first year of study in his PhD candidature through the University of Queensland to further this work. This research will allow the identification of combinations of native species best suited to specific soil types in the region based on extensive native forest datasets used in the initial analysis of Vanclay. Additional data will be collected from CRRP plots and other native species plantings in the Wet Tropics in order to adapt growth equations of Vanclay to mixed species restoration plantings. While some information on site species matching and combinations are already available for commonly planted species (usually those with a high timber value), there is a scarcity of information about less common species. This research will help address this information deficit about less commonly planted species.

Extension of Bayesian Belief Network models of landholder adoption of CRP's to suit landscape modelling

Over the past year the project team has developed a series of Bayesian Belief Networks used to identify the intervention (or policy leverage) points relating to the adoption of currently recommended practices by rural landholders based on the responses to the rural landholders' survey. This work will now be further explored to attempt to produce models of landholders' decision making in relation to the adoption of currently recommended practices.

We further continue to develop and submit a series of journal articles to Australian and international publications describing the work that has been undertaken for the project over the past three years.

Project Outputs/Outcomes

The results from the study of 'hobby farmers' and 'lifestylers' will help to answer important questions about these 'non-agricultural' rural landholders in terms of who they are, what are their management practices, what is their potential contribution to regional NRM objectives, and the threats they pose to the regions natural resources. The research will help to identify ways for Terrain and other land management agencies to engage these landholders.

Research to develop growth equations for native tree species in the Atherton Tablelands will assist those interested in developing revegetation programs to better select species to suit site conditions and project objectives.

The development of Bayesian Belief Networks of landholders' decision making in relation to the adoption of recommended management practices will assist efforts to model the potential impacts of policy and program alternatives across the rural landscape using GIS, multiple criteria analyses and agent-based modelling studies. The research will improve the ability to predict the likely responses of different types of landholders already defined by the project to variations in NRM policies and programs.

The development of journal articles will allow for publicising the results of the MTSRF funded research to Australian and international audiences.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
b	Report on the extension of BBN models of landholder decision making to use in landscape modeling	15 Nov 2009
a	Publish report with attribution of MTSRF funding from case studies to extend profiles of rural 'lifestyle' and 'hobby farm' landholders	15 April 2010
a and b	Submission of journal articles related to Project 4.9.4	15 June 2010

Project 4.9.4 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**UQ**
Signing of contract	July 2009	$25,000
Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report on Extension of BBN models of landholder decision making (with attribution of MTSRF funding)	15 November 2010	$30,000
Draft report with attribution of MTSRF funding on case studies of the hobby and lifestyle landholders	15 February 2010	$25,000
Submission of journal articles related to research completed under Project 4.9.4 (with attribution of MTSRF funding)	15 June 2010	$43,500
Total MTSRF Funding		**$123,500**

Project 4.9.4 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$123,500	-	$123,500
MTSRF Visual Documentation*	$1,500	-	$1,500
GBRMPA	-	-	-
Terrain	-	$12,500	-
SCU	-	$22,500	-
UQ	-	$198,800	$198,800
Total	**$125,000**	**$233,800**	**$358,800**

* A total of $1500 is held by the RRRC for Visual Documentation for this project (see Theme 5).

University of Queensland Project 4.9.4 Budget 2009/10

Item	MTSRF	UQ – In Kind	Total Cost
Salaries**	$95,000	$64,300	$155,300
Operating	$9,600	$10,000	$21,600
Travel	$10,400	-	$12,400
Communication / Extension[#]	$8,500	-	$8,500
Capital	-	-	-
Institutional overheads	-	$147,000	$147,000
Total	**$123,500**	**$221,300**	**$344,800**

* SCU are providing in-kind to UQ on this project. UQ are to report against that in-kind contribution.

** Includes Research Fellow ($84,200) and casual research assistance ($10,800).

[#] Presentation of research results and planning meetings with end users and other researchers.

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.5: Restoring tropical forest landscapes

Project Leader and Host Organisation

Dr Carla Catterall, Griffith University (GU)

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Carla Catterall	GU	Project leader and researcher. Senior ecologist.	0.25
Research Fellow tba	GU	Research fellow and key scientific researcher across objectives. Community ecologist.	1.00
Ms Kylie Freebody	GU	Research assistant. Plant ecologist and revegetation practitioner.	0.50
Dr Amanda Freeman	GU	Research fellow in objective (b). Wildlife and restoration ecologist.	0.40
Dr Catherine Moran	GU	Collaborator in objective (b). Wildlife/conservation ecologist.	0.10
Dr John Kanowski	Australian Wildlife Conservancy	Collaborator in objectives (a,b). Wildlife/conservation ecologist.	0.05
Ms Debra Harrison	Terrain NRM Ltd / GU	Research assistant and facilitator in objective (c). Ecologist and information manager.	0.70
Ms Rowena Grace	Terrain NRM Ltd	End-user collaborator in objective (a). Biodiversity manager.	0.10
Catchment coordinators	Terrain NRM Ltd	End-user collaborators in objective (c). Vegetation managers.	0.20
Dr Allan Dale and Ms Carole Sweatman	Terrain NRM Ltd	End-user collaborators in objective (c). Senior environmental planner.	0.05
Dr Grant Wardell-Johnson	Curtin University	Research collaborator in objectives (b) and (c). Wildlife ecologist.	0.05
Drs Aki Nakamura and Chris Burwell	Queensland Museum	Research collaborators in objective (b). Insect and restoration ecologist.	0.05
Dr Alice Crabtree	Australian Trust for Conservation Volunteers	Research collaborator in objective (b). Conservation/restoration practitioner.	0.05
PhD Student	GU	Researcher on sub-projects of objective (b). Restoration ecologist.	0.50

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
Alliance for Sustainable Tourism	Melinda Connolly
Terrain NRM Ltd	Allan Dale
EPA	TBA
WTMA	Steve Goosem
Australian trust for Conservation Volunteers	Alice Crabtree

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This project will advance knowledge and practice in understanding and managing forest restoration and degradation for biodiversity outcomes in Wet Tropics landscapes. It will help build a functional understanding of the ecological processes involved, and will develop and apply tools for monitoring and evaluation of forest disturbance, recovery and restoration, for end-users and researchers. Project activities will also facilitate a coordinated approach to reforestation and restoration, involving interaction between scientists, land managers and the wider community.

Key Objectives

(a) Develop and apply toolkits and indicators for monitoring and evaluation of degradation and restoration.

(b) Develop and communicate a functional understanding of reforestation and restoration processes.

(c) Improved facilitation and future optimisation of regional investments and management actions.

Project / Task Methodology

Objective (a): Toolkits and indicators: monitoring and evaluation of reforestation success

In collaboration with stakeholders, this project will develop user-friendly but ecologically meaningful toolkits for monitoring progress of vegetation condition and biodiversity at sites whose vegetation is changing because of either impacts (including land clearing and cyclones) or recovery processes (including regrowth, restoration and reforestation). This work is supported in part by Terrain NRM.

The series of monitoring toolkits will provide guidance in design, data collection, analysis and interpretation, and will include written materials and computer-based data management and summary tools. They will be applied to assess both improvements in vegetation condition and biodiversity in reforested sites, and impacts of cyclone Larry, in relation to measurements at relatively-intact forest reference sites. The toolkits will draw on relevant research (including Rainforest CRC Project 5.2 and this Project 4.9.5(b)), and will be tested by end-users, with the assistance of Terrain NRM staff and revegetation groups, and revised based on their feedback. Toolkit development includes the establishment of baseline and

reference states and measurements, against which progress at impacted or reforested sites can be judged, and which allow for background spatio-temporal variation in environment and biota.

The monitoring toolkits will be applied to revegetated sites, including NHT1 and NHT2 sites, with the involvement of Terrain NRM staff. The results will both provide data on the progress of reforestation at these sites and help refine the toolkits. The monitoring protocols will also be applied to assess impact and recovery at both forest and replanted sites affected by cyclone Larry. Information from this project, and from the monitoring of revegetated sites by end-users, will be used to identify ecologically-meaningful and cost-effective indicators of restoration and degradation.

Objective (b): Reforestation processes: functional understanding of reforestation processes

This task will advance knowledge of the ecological processes involved in forest (vegetation and biodiversity) degradation and recovery within rainforest landscapes. Initially, a scoping study will identify priorities for new data collection, based on a synthesis of current knowledge of reforestation and degradation processes. Once priorities are defined, data collection will involve field measurements of aspects of biodiversity and vegetation condition, including (a) by professional ecologists and (b) by application of the monitoring toolkits. Data will be collected at sites which have been selected to provide replication within experimental designs that are focused on factors such as area, establishment style (ecological restoration, forestry or regrowth), type of disturbance (cyclone, clearing, or fragmentation), isolation, context and age. Some data collection will involves re-surveys to determine vegetation and biodiversity change at sites previously assessed in Rainforest CRC Project 5.2. Additional data will be obtained from manipulative trials of key agents and processes affecting the development of reforested and regrowth areas.

The data obtained from this work, together with information from Rainforest CRC Project 5.2 and other relevant studies, will be analysed to examine relationships between controlling and response variables, and the performance and surrogacy value of a range of potential indicator attributes (including vegetation structure, floristics, and selected faunal taxa). The results of the analyses will be used to: (a) refine a conceptual model of reforestation processes, applicable to assessing reforestation trajectories and guiding management interventions in reforested sites; (b) identify cost-effective rehabilitation practices, especially where these have potential over large land areas, including different forms of plantation design, and management of regrowth; and (c) identify factors associated with the impact of cyclone Larry on vegetation and biodiversity, and the rate of recovery of vegetation and biodiversity. The cyclone work has been supported in part by TLJV.

Objective (c): Facilitation and futures: facilitating and optimising regional investments and management

This component aims to improve regional-scale coordination of investments in reforestation, and to develop and implement reporting protocols for improvements in resource condition, within the Wet Tropics NRM framework. This will require participation in, and contribution to, the reporting and management systems developed for the Wet Tropics NRM Regional Investment Strategy (RIS) and Management Action Targets (MATs). This work is supported in part by Terrain NRM.

Information on the costs of revegetation projects (e.g., obtained from NHT reporting) will be integrated with the results of on-ground assessment of biodiversity and vegetation condition, from the application of the monitoring toolkits. This and related information (e.g., from Rainforest CRC Project 5.2, and collaboration with MTSRF Project 4.9.4) will be used to quantify production-biodiversity trade-offs and synergies. Evidence-based criteria for

decision-making about the quality, quantity and spatial context of reforestation actions, especially in relation to long-term biodiversity outcomes, will be developed and communicated. Project Workshops will be held with stakeholders to integrate and disseminate information on restoration strategies, and to encourage the development of experimental management approaches to reforestation through collaboration between scientists, funding bodies and stakeholders. Activities will also include liaison with MTSRF Projects 1.2.1 (rainforest and catchment status and trends), 4.9.3 (development of rehabilitation strategies for retired linear infrastructure), 1.4.3 (threats to forest remnants), and regional initiatives which are looking at the role of revegetation in catchment management and carbon sequestration.

Project Outputs/Outcomes

[#] These outputs/milestones will have been achieved prior to 2009/10.

[##] These outputs/milestones held over from 2008/09 to 2009/10.

** These outputs/milestones are primarily supported by MTSRF (including in-kind from GU).

* These outputs/milestones are partially supppprted by MTSRF (including in-kind from GU), but also require funds and in-kind contributions from TerrainNRM.

Outputs/milestones without asterisks are not dependent on MTSRF funds, although they will benefit from the relationship with MTSRF.

Task	Output / Milestone	Date / Timing
(a)	End user workshop on monitoring revegetation	2006-2007[#]
	Book chapter on monitoring revegetation**	2006-2007[#]
	Monitoring toolkit version 2*	2007-2008[#]
	Condition report NHT1 sites*	2007-2008[#]
	User workshop on monitoring biodiversity of revegetation*	2007-2008[#]
	Monitoring toolkit version 3*	2008-2009[#]
	User workshop on monitoring revegetation*	2008-2009[#]
	Scientific paper on biodiversity indicators in reforestation**	2008-2009[#]
	Scientific paper on community-based monitoring**	2009-2010
	Revised monitoring toolkit*	2009-2010
(b)	Research workshop on reforestation processes and trajectories**	2006-2007[#]
	Paper on invertebrates and reforestation**	2006-2007[#]
	Book chapter on reforestation and biodiversity**	2006-2007[#]
	Scientific paper on conceptual model of reforestation processes**	2007-2008[#]
	Fact sheet on reforestation processes**	2007-2008[##]
	One or two scientific papers on an aspect of degradation or reforestation process**	2008-2009[#]
	Fact sheet on restoration and reforestation in practice**	2009-2010
(c)	Presentation on strategic reforestation to user workshop*	2006-2007[#]
	Book chapter on production-biodiversity value trade-offs**	2006-2007[#]
	Regular liaison with State, Commonwealth regarding RIS and MAT reporting*	2007-2010
	Reporting system for restoration works developed by Terrain NRM	2007-2009[#]
	Stakeholder workshop on strategic approaches to reforestation*	2007-2008[#]
	Article on restoration costs and benefits**	2008-2009[##]
	Workshop on integrating reforestation processes and outcomes into Terrain NRM RIS*	2008-2009[#]

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a)	Scientific paper on outcomes/monitoring of community-based restoration**	June 2010
(a)	Revised monitoring toolkit*	June 2010
(a), (b)	Spoken papers on restoration outcomes presented to two international conferences (International Ecological Congress; Society for Ecological Restoration International)**	August 2009
(b)	Completion of data collection in reforestation biodiversity study**	November 2009
(b),(c)	Fact sheet on reforestation processes and restoration in practice**	November 2009
(c)	Article on restoration costs and benefits submitted to journal**	November 2009
(a), (b), (c)	Final report on achievements of this project in relation to milestones and broader objectives**	June 2010

** These outputs/milestones are primarily supported by MTSRF (including in-kind from GU).

* These outputs/milestones are partially supported by MTSRF (including in-kind from GU), but also require funds and in-kind contributions from Terrain NRM Ltd or other partners.

Project 4.9.5 Milestone Payments 2009/10

For 2009/10 outputs only	Date	Terrain NRM	GU	MTSRF
Milestones		**GU**	**GU**	**GU**
• Payment on signing		-	-	$30,000
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-	-
• Completion of field data collection in reforestation biodiversity study** • Fact sheet on reforestation processes and restoration in practice**	15 Nov 2010	$36,450	-	$33,500
• Article on restoration costs and benefits submitted to journal**	15 Feb 2010	-	-	$30,000
• Final report on achievements of this project in relation to milestones and broader objectives** • Scientific paper on outcomes/monitoring of community-based restoration** • Revised monitoring toolkit*	15 June 2010	-	-	$30,000
Total MTSRF Funding		**$36,450****	**$20,000**	**$123,500**

* Total includes funds held for Visual Documentation.

** To be confirmed; pending outcome of funding process for Terrain NRM

Project 4.9.5 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$123,500	-	$123,500
MTSRF Visual Documentation	*$1,500	-	$1,500
Terrain NRM Ltd (3rd party contract)	$36,450	$30,000	$66,450
Griffith University	$20,000	**$181,000	$201,000
Australian Wildlife Conservancy	-	$10,000	$10,000
Curtin University	-	$5,000	$5,000
Australian Trust for Conservation Volunteers	-	$10,000	$10,000
Eacham Community Revegetation Unit (Shire Council)	-	$10,000	$10,000
Queensland Museum	-	$5,000	$5,000
Total	**$181,450**	**$251,000**	**$432,450**

* A total of $1,500 is held by the RRRC for Visual Documentation for this project (see Theme 5).

** Includes $20,000 internal Griffith University cash contribution but excludes institutional overheads.

*** To be confirmed; pending outcome of funding process for Terrain NRM

Griffith University Project 4.9.5 Budget 2009/10

Item	MTSRF Funds	Terrain NRM Cash	GU Cash	GU In-kind	Total Cost
Salaries	$81,490	$26,700	$20,000	$73,500	$201,690
Operating	$17,411	$3,100	-	-	$20,511
Travel	$8,706	$3,000	-	$2,500	$14,206
Communication / Extension	$15,893	$3,650	-	-	$19,543
Capital	-	-	-	-	-
Institutional overheads	-	-	-	$105,000	$105,000
Total	**$**123,500	**$**36,450	**$**20,000	**$**181,000	**$**360,950

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.6: Strategic natural resource management and land use planning

Project Leader and Host Organisation

Dr Cathy Robinson, CSIRO

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Cathy Robinson	CSIRO	Overall project leader. Principal investigator of Project 4.9.6a (catchment and regional planning)	0.35
Mr Bruce Taylor	CSIRO	Researcher 4.9.6a (social and institutional appraisal in resource planning and policy)	0.3
Dr Tabatha Wallington	CSIRO	Researcher 4.9.6 a (social dimensions of NRM decision-making and assessment)	0.1
Dr Rosemary Hill	CSIRO	Principal investigator 4.9.6b (collaborative planning and biodiversity conservation)	0.25
Dr Kristen Williams	CSIRO	Researcher 4.9.6b (biogeography and conservation planning)	0.12
Dr Petina Pert	CSIRO	Researcher 4.9.6b (ecology)	0.16
Dr Anthea Coggan	CSIRO	Principal investigator of 4.9.6c (environmental economics and market based instruments)	0.37
Dr Stuart Whitten	CSIRO	Researcher 4.9.6c (environmental economics and decision making)	0.07

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
Alliance for Sustainable Tourism	Annie Riddet
Terrain NRM Ltd	Allan Dale
QEPA	TBC
WTMA	Andrew McLean
Reef Water Quality Alliance	Rachel Eberhard
Queensland Canegrowers	Tim Wrigley
Saving the Wet Tropics Biodiversity Project Alliance	tba
DEWHA	Chris Murphy/Adam Cowell

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

This project will design and test implementation approaches for improved natural resource management and conservation. This research is based on an adaptive management planning framework with a focus on effective implementation that seeks to integrate social, economic and ecological systems. The key longer term outcome being targeted in this research is the improvement in the management of natural resources and supply of ecosystem services on private land. Our research focuses on achieving this through:

- Improved planning and institutional arrangements underpinning biodiversity, water quality and wider ecosystem services in the GBR region whilst maintaining viable regional industries and communities; and
- Building effective partnerships between researchers, research institutions, resource managers, policy makers, government and non-government agencies that increase the relevance and impact of science in natural resource and regional decision making and governance.

Key Objectives

(a) To develop and test rigorous cost-effective water quality management model to inform effective implementation approaches for water quality improvement

(b) To develop a rigorous local area planning framework for biodiversity, incorporating values and ecosystem services, based on regional ecosystems, threatened species, threatening process and beneficial processes provided by landholders and applied through case studies.

(c) To refine, tailor and apply the concept of market based instruments for implementing ecosystem goods and services specifically for the purpose of using offset schemes for environmental conservation in developing areas.

Project/Task Methodology

The methods and goals to meet the above objectives are tightly coupled to NRM end-user interests and needs. Care is taken however to ensure the research approach remains strategic and science–focused and not a substitute for the operational planning responsibilities of our partners. Building upon these active partnerships with regional NRM groups, we will develop concepts and methods of much wider strategic relevance to the disciplines of environmental planning and management across the GBR region.

Developing beneficial shorter-term outputs from the project relies on i) an ongoing dialogue with end-users to influence specific research questions and their priority; and ii) incorporating outputs from other projects to support the use of best available science in a focused and accountable policy environment. The main sets of outputs from the research are:

1. **Models and conceptual frameworks** to inform the construct of more rigorous and effective NRM planning at various scales
2. **Decision support tools** stemming from management requirements that enable the science outputs to be applied effectively in GBR management, biodiversity conservation planning, policy development and reporting processes,
3. **Demonstrations, through case study application, of innovative planning solutions and instruments** that incorporate best available science within the constraints and opportunities provided by regional socio-economic systems and governance, and

4. **Discussion papers, workshops, guidelines and collaborative projects** that communicate and build regional capacity to implement the science including the capacities of science providers to operate in this (environmental planning) setting.

In the longer term, key outcomes from the project will enable:

- Improved planning and institutional arrangements underpinning biodiversity, water quality and wider ecosystem services in the GBR region whilst maintaining viable regional industries and communities with high levels of adaptability, and
- Effective partnerships between researchers, research institutions, resource managers, policy makers, government and non-government agencies that increase the relevance and impact of science in natural resource and regional decision making and governance.

Objective (a): Strategic NRM planning for Water Quality Improvement

This project will construct a rigorous framework to evaluate alternative environmental management strategies for water quality improvement in North Queensland including their environmental, social and economic performance. The focus is on catchment and regional scale programs. The task is closely integrated with the work in the Water Quality Program (Program 7) of MTSRF. Specific tasks are outlined below.

- Develop a water quality management model that produces cost-effective programs of action (MATs) that are suited to socio-economic context and can be implemented to meet environmental targets (RCTs).
- Identify and synthesise the potential management actions in key sectors and industries that might be implemented to achieve those targets and the costs and efficacies of those management actions (in conjunction with other projects).
- Develop and test a knowledge integration monitoring and reporting framework that would provide rigorous and consistent information on management responses (in conjunction with other projects).
- Assess the capacity of resource users and management institutions to adopt management actions.
- Conduct an institutional analysis of the potential industry, government and community actors, roles, rules and arenas through which actions can be implemented.
- Implement the framework for at least one North Queensland region or catchment.

Objective (b): Biodiversity values in regional and local area planning

This project develops a rigorous local area planning framework based on principles of adaptive and collaborative management. The framework utilises biodiversity metrics that explicitly incorporate the effects of landscape function in addition to biological pattern and addresses the interacting effects of habitat quality, condition and connectivity. Contextually, biodiversity metrics, also commonly termed ‘surrogates’ will be designed to support a range of strategic NRM and land use planning requirements, integrating data and knowledge generated through this and other programs. Specific tasks are outlined below.

- Develop a rigorous, adaptive, collaborative local area planning framework for biodiversity and through this framework apply and test the effectiveness of relevant tools and engagement processes at each stage of the planning process. Identified stages and tools currently under investigation include: exploratory stage—historical trends analysis, natural and cultural values significance assessment, biodiversity metric development, stakeholder analysis; platform building stage—local governance establishment (Mission Beach Habitat Network Action Committee), scenario generation, participatory decision support tool design; negotiation stage—Landscape Toolkit decision support system, biodiversity

analysis under alternative land use configurations, scenario evaluation; implementation stage—offset policy and market design, devolved grant/tender development; evaluation stage—participatory workshop-based review.

- Incorporate habitat suitability, connectivity and fragmentation effects in the design and development of biodiversity persistence metrics.
- Test the effectiveness of generated biodiversity metrics in capturing and valuing different elements of biodiversity, including species turnover and phylogeny. In particular contrast taxon groups and new metrics with the Regional Ecosystem classification and with the predominantly structural vegetation types of the Stanton and Stanton mapping.
- Identify and value both unique areas and complementary areas for the protection or enhancement of biodiversity values based on regional ecosystems, threatened species, threatening process and beneficial processes provided by landholders through case studies in local area planning.
- Conduct case studies that ensure the science developed is applicable to the requirements of local area and NRM planning. Notwithstanding capacity, the case studies enable the project team to respond or react to the short-term needs and priorities of management agencies where datasets and planning timeframes also allow. To achieve this, we will work with identified project teams in MTSRF RIS Theme 4 (4.9.3) and Theme 1 (1.4.3) and collaborate with QPWS, EPA, WTMA and FNQNRM Ltd on predefined case studies. These include, but are not limited to: a) Daintree, b) Mission Beach and surrounding areas, c) Myola. d) Tully-Murray Flood Plain. e) Southern Atherton Tablelands. f) Cairns Northern Beaches. h) FNQ Regional NRM Plan review and revision
- As knowledge accumulates in the development of biodiversity metrics, we will incorporate new metrics for species turnover and issues of fragmentation, habitat quality, threatening processes and biodiversity persistence into the valuation and prioritisation protocols.
- Assess priority biodiversity areas under alternative scenarios for land use identified in regional NRM plans and evaluate the potential effectiveness of investment schedules for biodiversity outcomes.

Objective (c): Implementing ecosystem goods and services

Ecosystems provide many goods and services from which humans benefit. These services include maintaining the water table, purifying water and air, decomposing waste, renewing soil fertility, controlling pests and pollinating plants. Urbanisation could have a positive or negative effect on environmental assets and the ecosystem services that they provide. In most urbanisation experiences the impact has been a negative one.

Normal market signals experienced by landholders primarily focus on goods for which they gain a private benefit, for example, the price of a block of land according to its housing development potential. Landholders are generally not rewarded for the environmental goods that the land also produces. This means that the value of these environmental goods is not signalled in tangible ways, and that land management decisions often fail to take account of their full natural resource management impact.

In theory, the undersupply of public goods such as ecosystem services can be remedied through some level of government intervention. Policy interventions by government can generally be divided into those that use regulation or coercion, or those that change the incentives faced by private landholders through the provision of information and facilitation of management agreements and/or payments.

Urban development already occurs subject to regulation, such as planning requirements. Despite this, negative impacts to ecosystem services continue to occur. This is because planning requirements can not cost effectively capture all the impacts of development (for

example the residual impacts on water quality of a cumulative increase in paved surfaces). An alternative to increased regulation is the use of incentives to motivate landholders in an urbanising setting to supply the land management required for the maintenance and enhancement of ecosystem services.

This research component will construct and apply a rigorous framework to analyse the incentive mechanisms available for the management of ecosystem services in urbanising environments in far North Queensland. This framework will be based on the policy design process of: understanding the problem; understanding the constraints and opportunities for improved policy; designing and implementing policy based on the problem and constraints (including institutional), and monitoring, evaluation and feedback. The evaluation of incentives in the policy design framework will be conducted in consultation with other MTSRF research projects as well as local actors and will specifically include:

- An analysis of the development pressures and trends, as well as the biophysical impact, of urbanisation on ecosystem services.
- An analysis of the ecosystem services of importance to the area under study.
- An analysis of the key market failures that result in undersupply of ecosystem services. This is essential to the design of an incentive based policy particularly a market based instrument (MBI).
- An assessment of the current formal and informal institutions and frameworks utilised to manage ecosystem services with urbanisation (landholder motivations, incentive schemes, regulation and planning for land management with and without development - this includes plans at the local, regional, state and federal level).
- A recommendation of a mixture of potential incentives as well as design parameters, with an indication of implications of the mix that could be utilised to improve ecosystem service management.
- If possible and time and budget permits a field or laboratory test of a specific incentive scheme or mix could be conducted.

Project Outputs / Outcomes

This suite of work responds to the critical challenge and reality that while multiple of millions of dollars have been invested in integrated plans to tackle complex environmental management issues across the GBR - many of these plans have failed to be designed or implemented effectively. We bring planning, institutional economic and (human and biophysical) geographical expertise to consider the efficacy of various planning 'instruments' (community-based planning, regional planning, market-based instruments) for particular environmental management purposes facing the GBR

Objective	Targeted Activity	Completion Date
(a.1)	Refine knowledge integration assessment framework to provide rigorous information on collaborative water quality management efforts, in consultation with government and regional collaborators	December 2009
(a.2)	Adapt SMART and knowledge integration framework for cross-regional assessment of water quality planning efforts in the GBR in collaboration with Reef-wide stakeholders	March 2010
(a.3)	Review and finalise, in collaboration with project partners, outcomes from SMART assessment of partnership design and knowledge integration needs for water quality programs	June 2010
a, b and c	Refine and implement Project and Task communication research synthesis and communication strategy targeted at industry, government and community groups to provide planning and decision-making approaches and information on water quality and biodiversity issues of concern	March 2010
a, b and c	Integrate biodiversity metric, market-based instrument and local and regional planning methods and approaches developed by Project 4.9.6 task a), b) and c) into a collaborative adaptive environmental management and decision-making framework for Reef catchments	June 2010
(b.1)	Generate and test local area planning frameworks and key tools including scenarios through the Mission Beach Habitat Network Action plan, participatory decision support with Landscapes Toolkit in the Tully-Murray Floodplain, and active landholder conservation in the Daintree	December 2009
(b.2)	Finalise in partnership with Action Committee, the Mission Beach scenarios and draft habitat network action plan and strategies including both unique areas and complementary rainforest bioregion land areas based on biodiversity persistence that can be incorporated into the local area and regional NRM plans; ensure review of optimisation strategy through Action Committee incorporating QPWS, EPA and other stakeholders, and through Projects 1.4.3 and 4.9.3	December 2009
(b.2)	Scope local area planning needs in key biodiversity/impact hotspots within the wet tropics bioregion with FNQRM Ltd, MTSRF Project 4.9.3 and other relevant researchers, and identify any additional sites for testing approaches	March 2010
(b.3)	Generate adaptive collaborative local area planning frameworks and key tools in for testing in second-tier case study sites	March 2010
(b.4)	Identify and apply dynamic prioritisation processes for habitat corridors, utilising biodiversity metrics that capture both unique areas, complementary and linkage analysis into the first and second tier local area planning case studies	June 2010

Objective	Targeted Activity	Completion Date
(b.5)	Review, in collaboration with project partners, outcomes from local area planning scenarios, decision support tool and biodiversity metric applications and implement research integration with parts (a) and (c) to generate synthesis aimed at community, industry and government to provide guidelines on best-practice approaches	June 2010
(c1)	Through a workshop of key researchers and policy makers, synthesise current North Queensland knowledge of offset concepts, showcase research on design principles and offset applications and document future knowledge needs.	December 2009
(c2)	Finalise network analysis of transactors in Mission Beach offset applications. In collaboration with project partners finalise understanding of the drivers of costs and benefits of the EPBC Act offset policy for viable cassowary objectives in Mission Beach.	March 2010
(c3)	Synthesise research outcomes of all MTSRF offset work into practical policy advice for offset program implementation (for Nth Queensland broadly) and refinement (for EPBC Act based offsets in Mission Beach).	June 2010

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
	Report 1 submission: Report on rigorous framework to evaluate key multi-scalar partnership attributes of water quality programs Outline for biodiversity planning science synthesis paper (incorporating outcomes from local area planning scenarios, decision support tool and biodiversity metric applications) and mechanisms for the integration with parts a and c Finalise in partnership with Action Committee, the Mission Beach scenarios and draft habitat network action plan and strategies including both unique areas and complementary rainforest bioregion land areas based on biodiversity persistence that can be incorporated into the local area and regional NRM plans; ensure review of optimisation strategy through Action Committee incorporating QPWS, EPA and other stakeholders, and through Projects 1.4.3, 4.9.3. Synthesise current North Queensland knowledge of offset concepts, design principles and applications	December 15
a.2, b.2, c.2	**Verbal report to Operations Committee:** Refine and implement Project and Task communication research synthesis and communication strategy targeted at industry, government and community groups to provide planning and decision-making approaches and information on water quality and biodiversity issues of concern Progress on the biodiversity planning science synthesis paper that integrates biodiversity metric, decision support tool and local and regional planning methods and approaches Finalise SMART partnership and knowledge integration framework to be used for cross-regional assessment of water quality planning efforts in the GBR Finalise network analysis of transactors in Mission Beach offset	March 2010

Objective	Targeted Activity	Completion Date
	applications. Finalise understanding of the drivers of costs and benefits of the EPBC Act offset policy for cassowaries in Mission Beach in collaboration with project partners. Evaluation of efficiency and insight into practical design improvements for the future	
c.1, b.2, c.3	**Report 2 submission:** Conduct an institutional analysis of the potential industry, government and community actors, roles and arenas through which actions can be implemented Integrate biodiversity metric, market-based instrument and local and regional planning methods and approaches developed by Project 4.9.6 task a), b) and c) into a collaborative adaptive environmental management and decision-making framework for Reef catchments Communicate to international science audience and regional and national community, industry and government stakeholders the biodiversity science synthesis that integrates biodiversity metric, collaborative decision support tool and local and regional planning methods and approaches. Review and finalise, in collaboration with project partners, outcomes from SMART assessment for partnership design and knowledge integration efforts for water quality programs Identify and apply dynamic prioritisation processes for habitat corridors, utilising biodiversity metrics that capture both unique areas, complementary and linkage analysis into the first and second tier local area planning case studies Synthesise research outcomes of all MTSRF offset work into practical policy advice for offset program implementation (for Nth Queensland broadly) and refinement (for EPBC Act based offsets in Mission Beach).	June 10 2010

Project 4.9.6 Milestone Payments 2009/10

For 2009/10 outputs only		MTSRF
Milestones	**Date**	**CSIRO**
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report 1 submission: • Report on rigorous framework to evaluate alternative management strategies for water quality. Regional and scaled up to GBR. • Outline for biodiversity planning science synthesis paper (incorporating outcomes from local area planning scenarios, decision support tool and biodiversity metric applications) and mechanisms for the integration with parts a and c • Finalise in partnership with Action Committee, the Mission Beach scenarios and draft habitat network action plan and strategies including both unique areas and complementary rainforest bioregion land areas based on biodiversity persistence that can be incorporated into the local area and regional NRM plans; ensure review of optimisation strategy through Action Committee incorporating QPWS, EPA and other stakeholders, and through Projects 1.4.3 and 4.9.3 • Synthesise current North Queensland knowledge of offset concepts, design principles and applications	15 Dec 2009	$80,500
Verbal update to operations committee: • Refine and implement Project and Task communication research synthesis and communication strategy targeted at industry, government and community groups to provide planning and decision-making approaches and information on water quality and biodiversity issues of concern • Progress on the biodiversity planning science synthesis paper that integrates biodiversity metric, decision support tool and local and regional planning methods and approaches • Finalise SMART partnership and knowledge integration framework to be used for cross-regional assessment of water quality planning efforts in the GBR • Finalise network analysis of transactors in Mission Beach offset applications. Finalise understanding of the drivers of costs and benefits of the EPBC Act offset policy for cassowaries in Mission Beach in collaboration with project partners. Evaluation of efficiency and insight into practical design improvements for the future	March 2010	$80,500
Report 2 submission: • Integrate biodiversity metric, market-based instrument and local and regional planning methods and approaches developed by Project 4.9.6 task a), b) and c) into a collaborative adaptive environmental management and decision-making framework for Reef catchments • Communicate to international science audience and regional and national community, industry and government stakeholders the biodiversity science synthesis that integrates biodiversity metric, collaborative decision support tool and local and regional planning methods and approaches. • Review and finalise, in collaboration with project partners, outcomes from SMART assessment for partnership design and knowledge integration efforts for water quality programs • Identify and apply dynamic prioritisation processes for habitat	10 June 2010	$80,500

For 2009/10 outputs only		MTSRF
Milestones	**Date**	**CSIRO**
corridors, utilising biodiversity metrics that capture both unique areas, complementary and linkage analysis into the first and second tier local area planning case studies • Synthesise research outcomes of all MTSRF offset work into practical policy advice for offset program implementation (for Nth Queensland broadly) and refinement (for EPBC Act based offsets in Mission Beach). • All reports/end products to include attribution of MTSRF funding.		
Total MTSRF Funding		**$241,500**

Project 4.9.6 Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$241,500	-	$241,500
MTSRF Visual Documentation*	$1,775	-	$1,775
CSIRO	-	$206,917	$206,917
Total	**$243,275**	**$206,917**	**$450192**

* A total of $1775 is held by the RRRC for Visual Documentation for this project (see Theme 5).

CSIRO Budget 2009/10

Item	MTSRF	CSIRO In-kind	Total Cost
Salaries	$208,275	-	$208,275
Operating	$10,000	-	$10,000
Travel	$23,225	-	$23,225
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$206,917	$206,917
Total	**$241,500**	**$206,917**	**$448,417**

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.7: Obj (a) Understanding and enhancing community resilience: Science and management integration project

Project Leader and Host Organisation

Dr Tim Lynam, CSIRO

Project Team 2009/10

Title	Organisation	Role	FTE
Dr Tim Lynam	CSIRO	Project co-leader, principal contributor to theory development, resilience indicators at GBR scale.	0.18
Research Assistant	CSIRO	Lead role in resilience indicators at GBR scale	0.09
Dr Samantha Stone-Jovicich	CSIRO	Lead role in resilience indicators at GBR scale	0.13
Dr Erin Bohensky	CSIRO	Lead role in resilience indicators at GBR scale	0.18

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
GBRMPA	David Wachenfeld, Paul Marshall
Dept of Infrastructure and Planning	Manfred Boldy
Reef Catchments Mackay Whitsunday	Will Higham
Townsville City Council	Chris Manning

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project Description / Task Objectives

To contribute a set of indicators of social resilience to water quality change at the GBR scale for use by scientists, communities, natural resource management agencies (government, NRM agencies and industry agencies) and a more generally applicable approach to developing these indicators.

More specifically the project objectives are as follows:

1) Make available to end users reliable indicators of social resilience to water quality change or to policies that seek to achieve water quality change;
2) Describe the approach to developing and using indicators such that the process is repeatable.

Project / Task Methodology

Aims

The project goal **is to develop a theoretically defensible and project-appropriate understanding of social resilience that contributes to decision making in relation to water quality change as well as the management interventions to achieve water quality targets at the scale of the GBR catchment area.** This understanding will be used to focus the development of indicators of social resilience designed to meet the needs of specific decision makers in specific decision making contexts.

Methodology

This project is designed to support planning and decision-making initiatives at the **whole-of-Great Barrier Reef catchment area** where the ReefPlan is implemented by the Intergovernmental Operations Committee and ReefPlan Partnerships, and their member agencies.

Three sources of information will be used to develop proto-indicators that will thereafter be tested against additional case study material and expert knowledge. These sources are a) existing theory; b) end-user knowledge and beliefs; and c) analyses of case studies. Simple probabilistic models will be used to integrate these different data sets and thence to test the indicators. Existing theory will be used to formulate the likely factors contributing to social resilience. This broad theoretical data will be grounded in the GBR region through interviews with key stakeholders and experts in water quality management in the GBR region to ensure local knowledge and understanding is used to strengthen the theoretically derived indicators. Case studies of water quality change, drawn from Australia as a whole to provide a broad contextual base for analysis will be used to collect data with which to challenge and then inform the initial indicator set derived from theory and grounded with local context and knowledge. All three data sets will be used to develop initial indicators of social resilience in the GBR that will then be tested against additional case study data. Finally a process of using (and refining) the indicators will be developed with specific end users.

Project Outputs/Outcomes

The specific outcomes of the project will be as follows:

1) Reliable indicators of social resilience to water quality change are available for use in the GBR region;
2) The approach used to develop and use the indicators is described sufficiently well that it would be repeatable;
3) An approach to collecting information for and analyzing the data on social resilience is available for use.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
1	BBN model of social resilience validated	Nov 2009
1	Best bet indicators identified, defined and documented	Feb 2010
2	Approach to developing and using the indicators documented	June 2010

Project 4.9.7 ext a Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**CSIRO**
Signing of Contract		-
Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-
Report on the model validation (with attribution of MTSRF funding).	15 Nov 2009	$24,000
Report on the indicators of social resilience (with attribution of MTSRF funding).	15 Feb 2010	$24,000
Final Report on developing and using the indicators (with attribution of MTSRF funding).	10 June 2010	$24,681
Total MTSRF Funding		**$72,681**

Project 4.9.7 ext a Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$72,681	-	$72,681
MTSRF Visual Documentation*	$652	-	$652
CSIRO	-	$73,649	$73,649
Total	**$73,333**	**$73,649**	**$146,982**

*A total of $652 is held by the RRRC for visual documentation of this project.

CSIRO Project 4.9.7 ext a Budget 2009/10

Item	MTSRF	CSIRO In-kind	Total Cost
Salaries	$71,681	-	$71,681
Operating	$1,000	$7,454	$8.454
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	$66,195	$66,195
Total	**$72,681**	**$73,649**	**$146,330**

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.7: Obj (b) Understanding and enhancing social resilience: science and management integration project for catchment-regional scale

Project Leader and Host Organisations

Professor Helen Ross, The University of Queensland (UQ)

Project Team 2009/10

Title	Organisation	Role	FTE
Prof. Helen Ross	UQ	Project leader, principal responsibility for project management and liaison with end users, principal contributor to case studies and theory development, resilience indicators at catchment/NRM region scales, implications for regional management and community engagement.	0.20
Dr Kirsten Maclean	UQ	Substantive fieldwork and data collection for case studies, substantial role in development of indicators, and liaison with end users.	1.00
Dr Michael Cuthill	UQ	Lead role in theory development, community engagement. Contributor to development of indicators of resilience and liaison with end users.	0.10
Dr Bradd Witt	UQ	Role in participatory case studies, contributor to indicators of resilience.	0.10

Summary Table of Research Users 2008/2009

Organisation	Organisational Contact
WTMA	Campbell Clarke, Nigel Hedgcock
Terrain NRM	Allan Dale, Karen Vella, Rachel Wicks
ARC (currently via WTMA RAAC)	currently inactive, consulted through Nigel Hedgcock of WTMA
GBRMPA	Doon McColl, John Rainbird
Girringun Aboriginal Corporation	Phil Rist

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

To contribute:

(a) A set of indicators of social resilience to water quality change for use by natural resource management agencies and partners (NRM regional bodies, government organizations and Indigenous people) focused at large catchment (regional body administration) scale, and

(b) A more generally applicable participatory approach to developing these indicators.

The indicators of social resilience will make important contributions to the knowledge framework and the design of status and trend report cards (the State of the Region Report), through providing an integrated set of indicators for use in monitoring and reporting social resilience to water quality change and for more general planning uses. The indicators will also contribute to the synthesis of information, and make important communication contributions.

Project / Task Methodology

Aims

The project goal **is to develop a theoretically defensible and project-appropriate understanding of social resilience that contributes to natural resource management and social planning, and decision making in relation to water quality change at large catchment – regional body scale in the Far North Queensland area.** This understanding will be used to focus the development of indicators of social resilience designed to meet the needs of specific decision makers in specific decision making contexts.

Two questions guide the project activities to achieve this goal:

1. What do decision makers need to know or understand about social resilience at the catchment - regional-body scale of interest, and how it relates to community and larger scales?
2. What investments are most likely to enhance, or detract from, social resilience in the regions of interest, and specifically in relation to water quality change?

Methodology

This project is designed to support planning and decision-making initiatives, the parties responsible for that planning, and their reporting or planning tools, at regional bodies' scale of interest, where regional planning is achieved through regional bodies and their partners, large protected areas and groupings of Indigenous Traditional Owners. It will be linked to proposed State of the Region reporting. It is designed to nest with communities' scale of interest, where Water Quality Improvement Planning and broader community capacity building are focal (by JCU), and to a larger regional scale of interest where ReefPlan is a key initiative (by CSIRO).

The project methodology is inductive and uses the conceptual framework developed for the project which was described in detail in the ARP 2 document (see Figure 1).

The project recognizes that scales are mutually influencing in resilience, and thus that indicators developed at this scale should as far as possible communicate with sets of indicators developed at other scales (community scale, within MTSRF) and for other endeavours (see extensive analysis of indicators of social development made for previous milestones). Some of the same indicators may apply at all scales, in other cases different indicators may be required to indicate one dimension of resilience, such as economic

dimensions. In decision-making, managers at 'larger' scales often design programs to influence change at finer scales, for instance incentives to encourage improvement of agricultural practices or the planting of riparian vegetation to improve water quality.

The methodology focuses on a strong and adaptive cycle of collaborative activity, involving evidence-based co-learning by end-users and research team, ultimately leading to synthesis of the key elements of social resilience and thence development of indicators, and identification of processes for using the indicators. Evidence from case study research and other primary data gathering (shown at right in Figure 1) provides data, draft indicators and important elements of process for the refinement and use of the indicators. The first cycle of collaboration provided the teams of researchers and their end-users (Terrain NRM, WTMA, Traditional Owners and GBRMPA) with a provisional view of what needs to be indicated (e.g. 'capacity'), and we are building up a suite of draft indicators towards the best ways of indicating each resilience concept (e.g. one or more indicators of capacity). At the same time the process for using those indicators is clarified progressively, through examination of the monitoring and reporting frameworks appropriate to our scale of interest and encouragement to end users to embed indicators in these. The method is iterative, both within the life of the project (provisional identification of domains and resilience concepts needing indicators, and improvement to indicators as they are proposed and data sought for them) and beyond the life of the project, since adaptive managers treat their underlying assumptions and their activities as available for continual improvement.

The project team works collaboratively with the Regional Project Partners through participatory processes for indicator development using 'social learning' methods. The focus of these methods is to build understanding of social resilience and regional partners' future information needs, then to design and refine indicators to measure and inform investments in regional social resilience. The indicators are designed to inform at least three planning processes: the regional NRM plan, Wet Tropics Management planning, and Aboriginal planning, as well as State of the Region reporting and the proposed MTSRF Atlas.

This collaborative process is informed by literature and data collected from secondary sources (especially an analysis of frameworks and indicators for social development), by primary data collection in 'case studies' to inform and refine the indicator development, and by the local knowledge of our partners.

Six regional-scale case studies focus primarily on two catchments, the Johnstone and Barron, ensuring a spread between upper, middle catchment and coastal areas, and adjacent marine areas. (These align with the State of the Region report development approach). They consider particular social-ecological systems broadly associated with water or with capacity and contemporary change issues likely to reflect resilience factors.

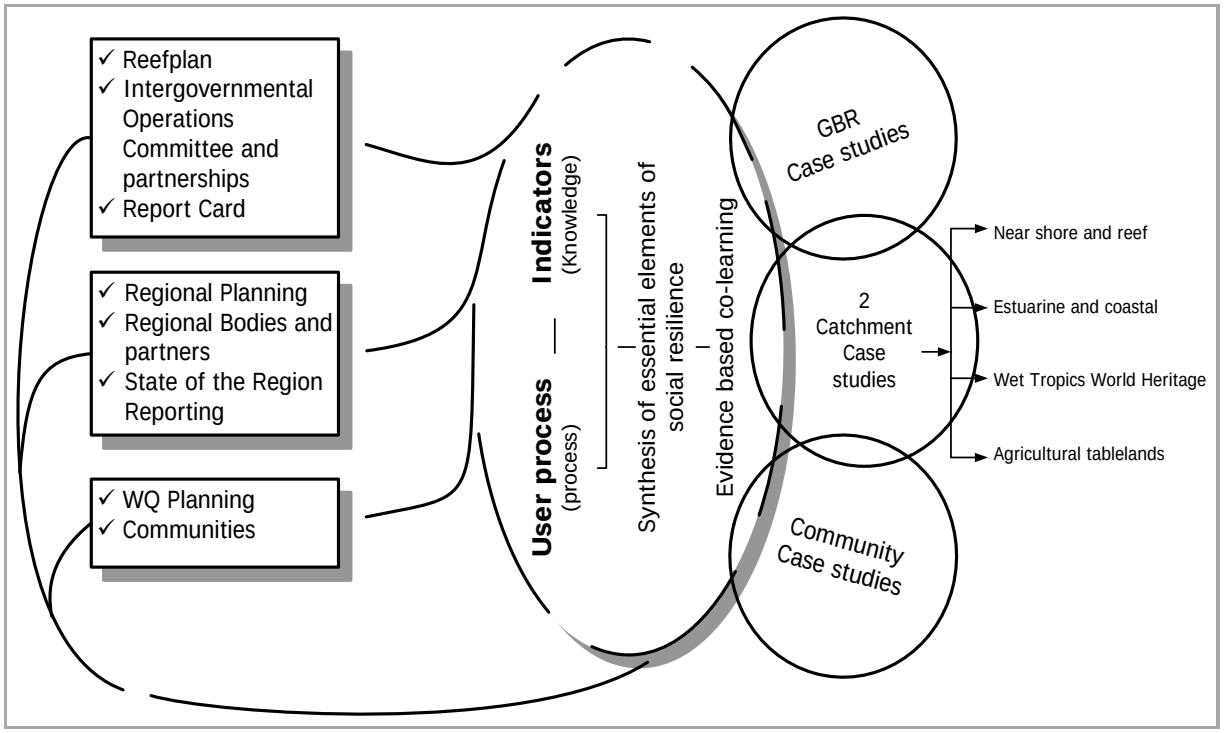


Figure 1: Conceptual framework for the development of indicators of social resilience through a collaborative process with decision-makers.

Project Outputs / Milestones

Objective	Targeted Activity	Completion Date
	• All data collection for case studies complete • All case study reports drafted and 'monitoring criteria' synthesized from the data • Draft of data sources for those 'monitoring criteria' so far identified • Regional partner meeting held to refine resilience concepts derived from case studies, and progress identification of suitable indicators	November 2009
	• Two to three community report-backs held in the region, for those interested in the case study results • Set of indicators refined and discussed with regional partners. • Prepare a verbal short summary of progress to date for RRRC meeting	March 2010
	• Case studies final report or publication • Test of a deliberative process (e.g. panel discussion) towards provision of qualitative indicators (where no quantitative equivalent is available). • Set of indicators finalized.	June 2010

N.B. 1-2 joint meetings will be held with JCU. State of Region and CSIRO teams and progress report provided on approach for cross-scale social indicator development. The dates for these will be decided during the MTSRF conference in April 2009.

Project 4.9.7 Milestone Payments 2009/10

For 2009/10 Outputs Only	Date	MTSRF	UQ
Milestones		**UQ**	**UQ**
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Completion of data collection for all case studies • Synopsis of draft case study reports drafted and 'monitoring criteria' derived • Draft of data sources for those 'monitoring criteria' so far identified • Notes of regional partner meeting held to refine resilience concepts derived from case studies, and progress identification of suitable indicators	1 Nov 2009	$24,200	$30,000
Report 2 submission: • Short report on community report-backs • Current status on set of indicators, and discussions with regional partners. • Verbal short summary of progress to date for RRRC meeting	1 March 2010	$24,200	-
Report 3 submission: • Case studies final report or publication with attribution of MTSRF funding. • Results of test of a deliberative process (e.g. panel	1 June 2010	$24,200	-

For 2009/10 Outputs Only	Date	MTSRF	UQ
Milestones		**UQ**	**UQ**
discussion) towards provision of qualitative indicators • Final set of indicators with attribution of MTSRF funding. • Statement on current status of articles submitted for publication (the team will be in a position to continue publishing for three more months)			
Total MTSRF Funding		**$72,600**	**$30,000**

Project 4.9.7b Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$72,600		$72,600
MTSRF visual documentation	$734		$734
UQ	$30,000	$190,440	$220,440
Total	**$103,334**	**$190,440**	**$293,774**

NB: UQ cash contribution is dedicated to balance of salary for the PostDoctoral Fellow.

UQ Project 4.9.7b Budget 2009/10

Item	MTSRF	UQ Cash	UQ In-kind	Total Cost
Salaries	$50,500	$30,000	$190,440	$270,940
Operating	-	-	-	**-**
Travel	$14,800	-	-	$14,800
Communication / Extension	$7,300	-	-	$7,300
Capital	-	-	-	-
Institutional overheads	-	-	-	-
Total	**$72,600**	**$30,000**	**$190,440**	**$293,040**

PROGRAM 9: SUSTAINABLE USE, PLANNING AND MANAGEMENT OF TROPICAL RAINFOREST LANDSCAPES

Project 4.9.7: Obj (c) Understanding and enhancing *community* resilience: science and management integration project

Project Leader and Host Organisation

Dr Margaret Gooch, James Cook University (JCU)

Project Team Commitments 2009/10

Title	Org.	Role	FTE
Dr Margaret Gooch	JCU	Project leader; principal contributor to theory development, community level resilience indicators; community level research	0.40
Dr Hilary Whitehouse	JCU	Contributor to community level resilience indicators; community level research methodology	0.20
PhD students: Ms Moni Carlisle Ms Snowy Evans Ms Renee Craft	JCU	Community level resilience indicators: • Water planning focus • Educational policy focus • Townsville WQIP focus	 1.00 1.00 0.50
Casual Research Assistants: (Dr Donna Rigano, Renee Craft, others as required)	JCU	Community level resilience indicators	0.50

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
Barron R CMA (BRICMA)	Tim Anderson, Brian Doyle, Jane Page, Penny Scott, Kim Forde
Butt Littering Trust, Australia	Sarah Bartlett
Cairns Regional Council	Peter Bradley, Kirby Doak (FNQROC), Darlene Irvine
Conservation Volunteers Australia	Mick Brady, Alice Crabtree
CSIRO-MTSRF State of the Region	James Butler, Leanne Cullen
Education Queensland	Cam McKenzie
GBRMPA	Doon McColl, Jason Vains, Sally Harman, John Rainbird
Terrain NRM	Allan Dale, David Haines, Karen Vella, Fiona Barron
Townsville City Council	Chris Manning, Greg Bruce
WTMA	Campbell Clarke Andrew Maclean, Max Chappell

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Background and Rationale

The background and rationale for this project is described in detail in the ARP 3 document, and remains unchanged. The project comprises three sub-projects, with team members working closely with local councils, NRM agencies, schools, and government organisations. The project task objectives remain unchanged, and are re-stated here. The emphasis of this project is on the *process* of collaborative research, rather than a series of *outputs* or *products*, which although valuable, do not reflect the long-term benefits of working in collaboration with end-users. Over the past three years, each team member has developed strong relationships with the end-users including Townsville City Council, Terrain NRM and Education Queensland.

Project / Task Objectives

We are undertaking innovative research to operationalise the concept of social resilience, which has not been attempted to date. Specifically, our objectives are to:

(a) Foster positive actions which can result in improved local water quality;

(b) Develop a set of indicators of community capacity for stewardship especially in relation to water quality issues for use by communities, natural resource management agencies (government, NRM agencies and industry agencies) and scientists;

(c) Investigate the influence of school-based sustainability initiatives on the resilience of school communities; and

(d) Investigate the influence of natural resource management (NRM) initiatives on community-scale social resilience.

Project / Task Methodology

The following two questions guide the sub-project project activities to achieve the objectives:

- What do decision makers need to know or understand about social resilience in different community settings (e.g. rural, urban, school communities)?
- What investments are most likely to enhance, or detract from, community resilience in relation to water quality change?

The initial phases of the project methodology were described in detail in the ARP 3 document. The remainder of this section describes the final phases of each of the three sub-projects.

Sub-Project One: Townsville case study (Margaret Gooch, Renee Craft)

Purpose: To assist planners, managers and community groups to assess residents' capacity for stewardship of Townsville's waterways.

End-users: Urban residents, planners and managers.

The overall aim is to build the capacity of Townsville residents to change their behaviour in relation to particular water quality targets identified through the Black Ross Water Quality Improvement Plan (BR WQIP) planning process. Phases of this sub-project are presented in Figure One.

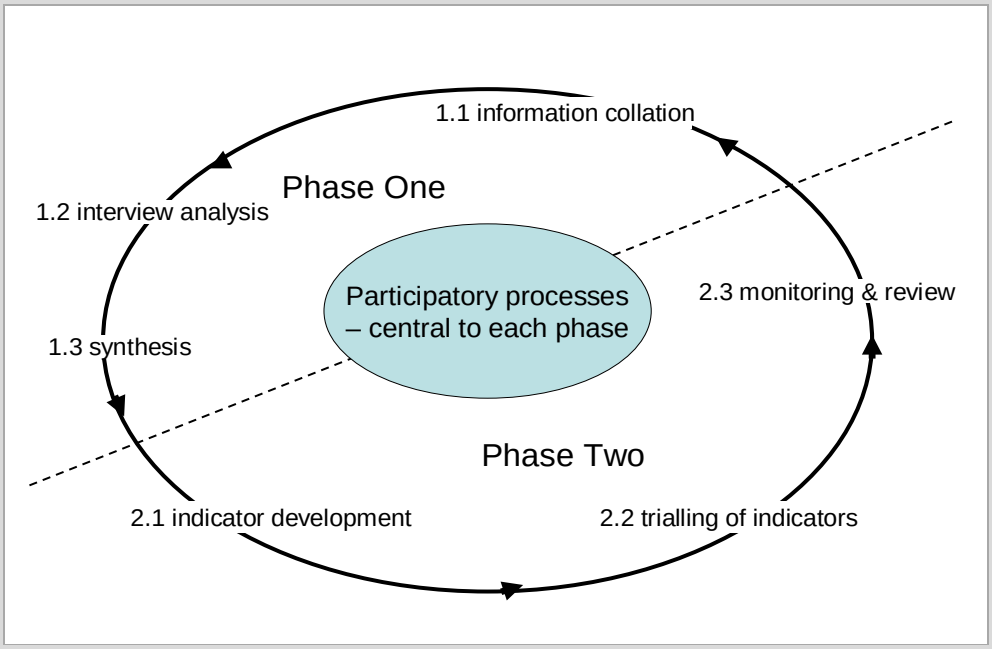


Figure 1: Phases of the Townsville Case Study

Phase One of the project is completed, and Phase Two is underway. The aim for Phase Two is to develop and test the validity of some of the indicators. For Phase Two, we have selected two water quality issues identified through Phase One of the study (litter and sediment load) to develop and test indicators that demonstrate willingness and ability to change behaviour.

During the next twelve months, JCU will finalise research into the uptake of specific behaviours by two specific communities within Townsville. These are:

- Smokers and their behaviour in relation to cigarette butt disposal; and
- Stakeholders involved in urban development and their impact on sediment erosion.

Measurable outcomes for this sub-project are:

Uptake of specific behaviours by Townsville smokers in response to a butt-littering campaign

Cigarette butt litter was identified in the personal interviews conducted in Phase One as being a major contributor to waterway pollution, and something that respondents were willing and able to do something about. Further, Townsville City Council and the Great Barrier Reef Marine Park Authority are keen to address this issue. To date, personal interviews of smokers have been undertaken to gauge their responses to particular strategies for reducing cigarette butt litter on the streets of Townsville. In addition, a Butt Litter campaign was launched in the first half of 2009 Townsville as part of a national strategy to create community awareness in relation to disposal of cigarette butt litter. If the campaign was successful, we should begin to see fewer cigarette butts being collected by volunteers such as CVA and GBRMPA staff, who regularly collect butt litter on the streets of

Townsville. In addition, we should see a change in attitude by smokers who previously littered the streets with their cigarette butts. Thus the final phase of this project is to:

- Analyse data gathered over time which reflects the amount of cigarette butt litter collected in particular locations across Townsville;
- Re-interview smokers, using an approach known as consensus analysis to see whether the campaign (i.e. the intervention strategy) helped to reduce barriers and enhance benefits of correct disposal of cigarette butts.

The consensus analysis includes a large survey across Townsville (probably door-to-door) to further analyse Townsville city residents' attitudes, beliefs, and views on cigarette butts and strategies for improving their proper disposal. The approach involves two stages of data collection and analysis, and uses a variety of techniques to elicit a range of responses.

Uptake of specific behaviours by Townsville building industry in response to a sediment reduction strategy

Sediment load in local waterways was identified in the personal interviews as being a major contributor to waterway pollution, and is an issue that needs urgent attention. This was also identified by end users, particularly the EPA, GBRMPA and TCC, as the most pressing issue for Townsville waterways. The strategy in this instance is to:

- Undertake personal interviews of key stakeholders in the building industry to identify attitudes to sediment erosion efforts;
- Implement one or two control measures (recommended by TCC and GBRMPA); and
- Assess the barriers and enablers in reducing sediment erosion.

This will be achieved by:

- Re-interviewing the stakeholders after the control measures are in place;
- Directly observing of their behaviour in relation to the control measures; and
- Measuring sediment load before and after the controls have been put in place.

The results of these strategies, combined with the results of the 2008 State-wide CATI survey (described in ARP 3) will feed into the development and implementation of a Townsville-wide survey designed by CSIRO Project 497 team members, who are developing a model of social resilience that describes communities within GBR catchments.

Sub-Project Two: Community level resilience indicators – Far North Queensland WQIP focus (Moni Carlisle, PhD student)

Purpose: To assist in decision-making around implementation of Water Quality Improvement Plans in Far North Queensland.

End-users: Primarily planners and managers.

Methodology

Baseline data in relation to defining both ecological and social resilience was obtained with the first round of focus groups involving communities and industries affected by the 1988 World Heritage Wet Tropics declaration. Using documents, literature and the community survey data provided by WTMA in relation to communities changing views of the Wet Tropics, a series of workshops and interviews were conducted to establish how resilience is defined. Qualitative data collected to date in relation to the WTMA forums has allowed for further exploration of what enhances and/or erodes resilience within the Wet Tropics. Data collected is now being used to contrast with monitoring and evaluation tools discussed within the literature within a social-ecological framework defines the case study for research. Data gained from understanding what enhanced and/or eroded community resilience in relation to the Wet Tropics listing will be used in similar forums/focus groups within a water planning context.

Data collection includes:

- Semi-structured Interviews with members of communities and industries impacted by the 1988 World Heritage listing of the Wet Tropics within the case study region;
- Interviews with key environmental planners and managers involved in both the world Wet Tropics listing as well as water quality planning across the Wet Tropics;
- Interviews with water planners directly engaged with Water Quality Improvement Plans (WQIPs) and Reef Plan at the local, state and federal levels;
- Collection of documents, data, reports related to both the Wet Tropics and WQIP; and
- Focus groups.

Schedule of work for the next twelve months:

- Continue extensive literature review primarily focusing on monitoring and evaluation tools/techniques/processes to measure changes in attitude;
- Continue data analysis
- Submit thesis

Sub-Project Three: PhD – Social-ecological resilience through school communities in Far North Queensland (Snowy Evans, PhD student)

Purpose: To assist in decision-making around sustainability initiatives in schools and school communities.

End-users: Decision-makers in schools (principals and teachers); curriculum writers and policy writers (e.g. Education Queensland staff, other government agency staff with an education focus.)

This study focuses on working with six schools in the Cairns Regional Council area that are known to engage in sustainability education to investigate the impact school-based sustainability initiatives have on school community resilience to environmental changes. For the purpose of data collection, the focus of this study has shifted from resilience to water quality to resilience to environmental changes. This is because first, it was found that school members find it difficult to conceptualise "resilience to water quality" and were reluctant to participate. Second, hardly any schools implement work on water quality, therefore, felt unable to contribute to the research. Environmental changes, on the other hand, is a concept Far North Queensland communities can relate to because (a) the landscape is rapidly changing due to development and (b) wide media coverage of environmental problems such as climate change which is likely to affect the Great Barrier Reef.

Methodology

Baseline data about sustainability initiatives in six schools in the Cairns Regional Council were collected, before an analysis of the influence of these initiatives was undertaken. This included examining school capacity for present and future sustainability work, and identification of barriers and enablers for the initiatives. The research is being undertaken from a social-ecological systems theoretical framework, using case studies.

Schedule of work for the next twelve months

- Complete data analysis and literature review
- Submit thesis

Project Outputs/Outcomes

Our objectives are derived from the overarching goal of increasing North Queensland's sustainability, and are stated in bold. Major outcomes and/or information relating to each objective are underlined.

(a) To foster positive actions which can result in improved local water quality

Information derived from community-based social marketing and consensus analysis strategies: These strategies are underway in Townsville focusing on cigarette butt litter and sediment reduction.

(b) To develop a set of indicators of community capacity for stewardship especially in relation to water quality issues for use by communities, natural resource management agencies (government, NRM agencies and industry agencies) and scientists

Frameworks for indicators of social resilience: We are working with CSIRO (James Butler and Leanne Cullen) to develop a framework for the development of indicators of social resilience at the community scale that will have practical application for NRM agencies and local councils. As well, we are working with Project 4.9.7 CSIRO team members to trial indicators of social resilience at the community scale through the implementation and analysis of a Townsville-wide social survey. Further, team members have been closely working with Terrain NRM in the Wet Tropics to integrate the State of the Region reporting and Reef Rescue Pathways to Impact. Moni Carlisle, PhD candidate, has been working closely with Terrain NRM to align community interests related to water quality planning into the State of the Region reporting and with the Wet Tropics Water Steering Committee. Snowy Evans and Hilary Whitehouse are developing indicators of social resilience within school communities that emphasise Education for Sustainability initiatives.

(c) To investigate the influence of school-based sustainability initiatives on the resilience of school communities

Information derived from project to generate greater awareness and uptake of sustainability initiatives in NQ schools: This work is being undertaken by Snowy through her PhD studies. She is working with her supervisors (Hilary and Margaret), Education Queensland and GBRMPA Reef Guardian Schools to complete this work

(d) To investigate the influence of natural resource management (NRM) initiatives on community-scale social resilience

Information about barriers and benefits relating to BMP in water planning: This work is being undertaken by:

- Moni through her PhD studies. She is working with her supervisors (Allan Dale, Hilary and Margaret), Terrain, WTMA, ACF, NRW, and Cairns Regional Council (FNQROC) and the Wet Tropics Water Steering Committee to complete this work.
- Renee through her PhD studies. She is working with her supervisors (Margaret Gooch, Anne Swinbourne – school of psychology, JCU, and Greg Bruce, Head of the TCC's office of Sustainability).

Through the delivery of these outcomes we should see:

- Changes in personal behaviour regarding cigarette butt litter in the Townsville area;
- Better management of sediment and reduction in sediment load into Townsville waterways, especially in the vicinity of new residential developments;
- Greater understanding of pathways to resilience within an educational context;
- A consolidation of educational work being done at a national level in relation to Education for Sustainability initiatives;
- Better arrangements for delivery of NRM management action targets (MATs), especially in relation to water quality;
- Better understanding of community contribution to NRM implementation as participants in policy and not solely as consumers (in relation to water asset); and
- Increased understanding of NRM in practice, especially in regards to partnership arrangements.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
(a), (b)	• Implementation of first phase of Townsville-wide social survey for consensus analysIsland (RC, MG, CSIRO)	November, 2009
(a), (b), (c) (d)	Progress report of each of the three sub-projects including: • Interim report of consensus analysis social survey (MG, RC; CSIRO) • Draft Indicator framework for Terrain NRM (MC) • Draft Indicator framework for Education Queensland for use in Education for Sustainability initiatives (SE)	March, 2010
(a), (b), (d)	• Joint meeting with UQ and CSIRO to finalise cross-scale social indicator development (all) • Completion of consensus analysis report for Townsville (MG, RC, CSIRO) • Submission of two articles about barriers and enablers relating to social resilience at the community scale – submitted to peer reviewed journals (all) • Submission of two PhD theses for examination (SE, MC) • Submission of Indicator framework to Terrain NRM for State of the Region reporting. (MC) • Submission of Indicator framework to Education Queensland for use in Education for Sustainability initiatives (SE, HW)	June 2010

Project 4.9.7c Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF	JCU
Milestones		**JCU**	**JCU**
• Project Leader to attend Operations Committee Meetings (three to four meetings per year).	2009/10	-	-
Report 1 submission: • Progress report on each of the sub-projects (all)	30 Nov 2010	$20,600	$10,000
Report 2 submission will include a progress report of each of the three sub-projects including: • Interim report of social marketing strategies for Townsville City Council and the Great Barrier Reef Marine Park Authority (MG, RC) • Draft Indicator framework for Terrain NRM (MC) • Draft Indicator framework for Education Queensland for use in Education for Sustainability initiatives (SE)	31 March 2010	$40,000	$10,000
Report 3 submission will include: • Minutes of joint meeting with UQ and CSIRO to finalise cross-scale social indicator development (all) • Final Report on the implementation and analysis of Townsville-wide social survey. (MG/CSIRO team) • Final summary of social marketing strategies focusing on a butt litter campaign and sediment reduction awareness-raising in Townsville. (MG, RC) • Outline of two articles about barriers and enablers relating to social resilience at the community scale – submitted to peer reviewed journals (all) • Outline of Indicator framework to Terrain NRM for State of the Region reporting. (MC) • Outline of Indicator framework to Education Queensland for use in Education for Sustainability initiatives (SE, HW) • All reports and end products will have appropriate attribution of MTSRF funding.	1 June 2010	$12,000	-
Total MTSRF Funding		**$72,600**	**$20,000**

Project 4.9.7c Community Scale (JCU) Budget

Year 4 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF	$72,600		$72,600
MTSRF Visual Documentation*	$733		$733
James Cook University	$20,000	$60,000	$80,000†
Total	**$ 93,333**	**$60,000**	**$153,333**

* A total of $733 is held by the RRRC for Visual Documentation for this project (see Theme 5).

† Based on 0.6 FTE @ Senior Lecturer scale; $20 000 contributions by JCU PhD scholarship program

Project 4.9.7c Community Scale (JCU) Budget 2009/10

Item	MTSRF	JCU Cash	In Kind	Total Cost
Salaries	$55,750	$20,000	$60,000	$135,750
Operating	$9,000	-	-	$9,000
Travel	$7,250	-	-	$7,250
Communication / Extension	$600	-	-	$600
Capital	-	-	-	-
Institutional overheads	-	-	-	-
Total	**$72,600**	**$20,000**	**$80,000**	**$152,600**

THEME 5 (PROGRAM 10)
ENHANCING DELIVERY

If the economic, social, cultural and environmental values of the Great Barrier Reef, Wet Tropics rainforests and Torres Strait are to be maintained despite rapidly increasing pressures, then management needs to be sustainable and informed by sound science.

The Marine and Tropical Sciences Research Facility (MTSRF) is producing scientific information with the specific purpose of enabling management, policy and practice to become more sustainable. However, experience worldwide has shown that simply producing relevant information from good science is not sufficient to change management, policy or practice for the better. Specific investment in strategic, creative, effective ways of transmitting synthesised scientific information to targeted end users is essential if delivery from large multidisciplinary research programs is to become more successful. Now that substantial quantities of relevant scientific information have started to flow from the entire range of MTSRF research projects, the scene is set for a considerable expansion of strategic delivery-enhancing activities under Theme 5.

The Theme 5 delivery mechanisms are the specific responsibilities of the Reef and Rainforest Research Centre, representing MTSRF in North Queensland. Where appropriate the Centre utilises contractual arrangements to partner with required expertise. Theme 5 is comprised of the following specific projects:

5.10	Enhancing delivery for the MTSRF	$737,500
5.10.1	Communication tools for MTSRF Projects	Funded through Themes 1-4
5.10.2	Communication, engagement and enhanced delivery for tourism operators in the Wet Tropics rainforests	$30,000
5.10.3	Communication, community engagement and enhanced delivery for Indigenous knowledge of the Wet Tropics rainforests.	$30,000

Project 5.10.1 has been developed in consultation and agreement with researchers participating in the MTSRF, and is funded from contributions from Themes 1-4. Outputs in previous years have included high quality digital video footage of science activities being conducted under the MTSRF. Although during ARP4 the focus of this project will shift to producing other strategic communication tools, the relevance to and use across the full scope of MTSRF research will be maintained.

Projects 5.10.2 and 5.10.3 are assisting communication between MTSRF researchers and two key groups; the terrestrial based Tourism Industry and Indigenous people. The intent is to facilitate these groups to interact with the MTSRF research community and to ensure both adequate and appropriate transfer of information.

The schedules for these projects are provided below.

Theme 5 Budget Summary

Title	MTSRF	In-kind	Total
Project 5.10 (Enhancing Delivery for MTSRF)	$737,500	-	$737,500
Project 5.10.1 MTSRF Communication Tools (aka Visual Documentation)	$63,754*	-	$63,754
Project 5.10.2 (Tourism)	$30,000	TBA	$30,000
Project 5.10.3 (Indigenous)	$30,000	-	$30,000
Total	**$861,254**	**TBA**	**$861,254**

* This project is funded from the total allocation against Visual Documentation from projects within Themes 1-4, and is not included in the total funding for Theme 5.

The total value of Theme 5 (Program 10) is $797,500 plus Visual Documentation funding of $63,754 through Themes 1-4.

PROGRAM 10: ENHANCING DELIVERY

Project 5.10 Enhancing Delivery of the MTSRF

Project Leader and Host Organisation

Reef and Rainforest Research Centre Ltd

Project Team Commitment 2009/10

Title	Organisation	Role	FTE
Dr Suzanne Long	RRRC	Project leader	0.8
Sheriden Morris	RRRC	Project contributor	0.3
Shannon Hogan	RRRC	Project contributor	0.7
Dr David Souter	RRRC	Project contributor	0.2
Mellissa Jess	RRRC	Project contributor	0.1
Hayley Gorsuch	RRRC	Project contributor	0.3
Toni Fulton	RRRC	Project contributor	0.1

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
Stakeholders	All end users of MTSRF research

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

The following is summarised from the Draft Strategic Plan to Enhance Delivery.

The broad objectives of activities and projects in Theme 5 are:

- To facilitate increasingly sustainable management of the region, in which decision-making is informed by sound science, by enhancing delivery of that scientific information to end users.
- To facilitate cooperation and collaboration both within MTSRF and between MTSRF, other research providers, and end users, such that the capacity for sustainable, informed management of the region is enhanced.
- During this process, to raise awareness of and demonstrate the value of the MTSRF to the community that has funded it.

Communication is the major tool that RRRC uses to achieve these strategic objectives on behalf of the MTSRF.

To fulfill these objectives efficiently, RRRC must identify high-priority information and convey it effectively to targeted audiences/end users. In this context, the following questions guide the preparation of every communication product emanating from RRRC:

1. How will communication of this research information help achieve our objectives?
2. To whom do we need to deliver this information if it is to help achieve our objectives? (end users and/or audience)
3. What form of communication will best facilitate the uptake of this information by the target audience/end user(s)? How can this be achieved most efficiently, given RRRC's limited resources?
4. How will we determine whether delivery of the information has been successful?

Identifying the message

While all the information produced through MTSRF is publicly available in the form of reports via the RRRC website, some research results are more relevant to the strategic objectives of the MTSRF than others. RRRC identifies high-priority messages into which the RRRC communication effort should be invested.

Identifying the audience

The RRRC needs to communicate its diverse messages to a very wide range of audiences, from federal government ministers through to members of the general public. Clear perception of the intended audience for each message is important, as understanding of the differing receptivity of audiences and end users is needed to enable communication products to be tailored to maximise the likelihood of uptake (i.e. to maximise delivery success).

Effective communication of the message

Delivery failure frequently prevents relevant research results from being incorporated into management responses. Careful consideration of how results are going to be most effectively communicated to end users is therefore a critical component of delivery success. RRRC communicates messages using a range of mechanisms, including (but not limited to) conferences, workshops, the RRRC website, fact sheets, newsletters, media releases, and synthesis reports. Templates and/or style sheets are used for all of these mechanisms to help ensure both coherence of message and appropriate badging.

Evaluating delivery success

The need to demonstrate value for money for public investment in research, along with a growing culture of accountability within research organisations, is increasing the emphasis on evaluation of delivery success. Most cases in which some evaluation has been attempted have involved the use of proxies for delivery success, such as number of reports distributed, frequency of positive media coverage, or the use of market research-type interviews, surveys or questionnaires. None of these methods used in isolation really quantifies delivery success as defined by the RRRC. The RRRC uses a multidisciplinary, comparative approach involving the identification and monitoring of appropriate indicators of delivery success, benchmarking surveys to establish baselines for the indicators, case studies of the effectiveness of particular delivery mechanisms, as well as monitoring of conventional statistical proxies of delivery success. The benchmarking survey will be repeated during ARP4 which will give an indication of success of attempts to enhance delivery over the past year. Periodic reporting on delivery success helps the RRRC to refine its delivery mechanisms and communication products accordingly.

In the fourth and final year of the Marine and Tropical Sciences Research Facility, the MTSRF research portfolio is particularly focused on delivering major outputs to address the key research priority areas identified in the Research Investment Strategy 2006-2010 (RIS). The RIS represents the collective view of scientific experts, business and industry leaders, government agencies, NGOs and community groups. In ARP4, there will be a correspondingly greater focus on delivering strategic synthesised information to fulfill the

obligations of the MTSRF to facilitate the adoption of research via the delivery of timely and relevant scientific information to key research end users. The successful delivery of these outcomes is already improving the sustainable use and management of the environmental assets of North Queensland, and demonstrating the value of the MTSRF investment to North Queensland.

Targeted Project Activities

Targeted activity
Delivery of synthesised, packaged research information to targeted end users in accordance with the Strategic Plan for Enhancing Delivery. This will include: • Ongoing development and management of the RRRC/MTSRF website such that it can act both as an archive and as a portal for disseminating MTSRF's latest research results and activities; • Metadata preparation and delivery; • Preparation and delivery of research and technical reports to the RRRC/MTSRF website; • Tracking and reporting of peer-reviewed journal articles of MTSRF-funded research; • Management and delivery of data, metadata and synthesised information covering each of the thematic and geographic areas of the MTSRF into the e- ATLAS; • Development of data agreement and negotiation of alignment of delivery systems for the e-ATLAS with DEWHA, WTMA, GBRMPA and NCCARF; • Strategically important messages identified and fifteen briefing notes on topical issues produced; • Preparation, packaging and delivery of six research synthesis reports aligned with the original Research Investment Strategy – such that their uptake by end users is facilitated (external expertise in writing, publications and delivery will be contracted where necessary); • Delivery of large final year MTSRF Annual Conference; • Opportunities for MTSRF research results to contribute directly to changes in management, policy or practice; use of innovative means to exploit these opportunities identified or created and documented; • Delivery of synthesised MTSRF science updates for each project within each research area to relevant Steering Committees; • Delivery of synthesised MTSRF science updates for each project to endusers; • Regular industry updates of synthesised relevant MTSRF research information; and • Regular community updates of synthesised relevant MTSRF research information.
Maintenance and refinement of the MTSRF engagement framework such that its functionality is increased. Activities will include: • Facilitating the critical functions of the Steering and Operations committees in engagement and peer review; • Developing and strengthening two-way knowledge transfer relationships with the full range of MTSRF end users (Pathway to Impact reporting); and • Developing and maintaining partnerships with other professional science communicators working for north Queensland research organisations, such that opportunities for delivery of MTSRF research are enhanced.
Evaluation of delivery success and adaptive management loop: • Repeat survey of selected end user groups, such that progress against last year's benchmark can be measured (external expertise will be contracted where necessary); • Evaluation of the delivery success of communication products, and incorporation of lessons learned into preparation of future communications products; and • Regular reporting to DEWHA regarding the delivery success of the MTSRF.

Project 5.10 Milestones 2009/10

For 2009/10 Outputs Only Milestones	Date	MTSRF To RRRC
Initial payment		$147,500
Written report provided to DEWHA containing descriptions of this quarter's activities enhancing delivery (Jul-Sep 2009), including copies of documents and reports as follows: • Maintenance of the MTSRF's engagement framework – details of this quarter's four Operations Committee meetings and three Steering Committee meetings, plus the minutes of the previous quarter's meetings • Synthesised MTSRF science updates for each project within each research area, delivered to relevant Steering Committees • Research Director's report to the RRRC Board • Four Essential Science delivery sessions featuring peer-to-peer communication with key end user groups – audiences will vary between quarters but will include local, state and federal government staff, management agencies, end user organisations such as Ergon or ports authorities, environmental NGOs and general public • Responses to requests from the Environment Portfolio and other federal government bodies for information/materials (usually 8-10 per quarter) • Four personal briefings delivered to federal and state government ministers and their advisors • Twenty personal briefings delivered to other end user groups (these end user groups will vary between quarters but will include Councils, NGOs, natural resource managers, etc) • Four Briefing notes on topical issues, delivered to DEWHA and relevant local, state and federal government staff, including ministers, senators and policy advisors • What's new with the e-Atlas - Progress report on data agreements, metadata and data input into the e-Atlas and technical alignment with the DEWHA, GBRMPA and WTMA • Details of eight activities enhancing engagement and adoption of the e-Atlas (activities will vary between quarters but could include end user briefings, responses to requests from e-Atlas users, e-Atlas training sessions) • Updates to the RRRC/MTSRF website, including the latest metadata list for publicly available technical, interpreted and synthesised information, highlighting additions this quarter • Website visitation statistics • One awareness-raising event for the MTSRF (for example participation in and distribution of MTSRF materials at relevant conferences) • Three Communiqués targeted to key end user groups (RRRC Communiques are strongly focused on MTSRF information - all scientific content is reviewed by scientists prior to publication – content and target end user group will vary each quarter. See http://www.rrrc.org.au/publications/communique_online.html for previous examples) • Four media releases (supplied to DEWHA for approval prior to release) or fact sheets distributing synthesised MTSRF information	28 Oct 09 (Q13)	$147,500

For 2009/10 Outputs Only Milestones	Date	MTSRF To RRRC
to the community and/or general public • Five MTSRF science updates for industry delivered at meetings with industry representatives • List of presentations delivered by RRRC staff and MTSRF researchers, with copies of presentations where possible • Evaluations of delivery success (eg media monitoring, number of newsletters distributed, or other indicator) In addition: • Evidence of consultation with key end user groups for input on future research directions and the new Research Investment Strategy, via meetings and/or research directions workshops • Final RRRC Annual Report 08/09 (if comments on draft are received from the CERF team by 30 Sep 09) • Draft Proceedings of the 2009 MTSRF Annual Conference provided to CERF team for comment		
Written report provided to DEWHA containing descriptions of this quarter's activities enhancing delivery (Oct-Dec 2009), including copies of documents and reports as follows: • Maintenance of the MTSRF's engagement framework – details of this quarter's four Operations Committee meetings and three Steering Committee meetings, plus the minutes of the previous quarter's meetings • Synthesised MTSRF science updates for each project within each research area, delivered to relevant Steering Committees • Research Director's report to the RRRC Board • Four Essential Science delivery sessions featuring peer-to-peer communication with key end user groups – audiences will vary between quarters but will include local, state and federal government staff, management agencies, end user organisations such as Ergon or ports authorities, environmental NGOs and general public • Responses to requests from the Environment Portfolio and other federal government bodies for information/materials (usually 8-10 per quarter) • Four personal briefings delivered to federal and state government ministers and their advisors • Twenty personal briefings delivered to other end user groups (these end user groups will vary between quarters but will include Councils, NGOs, natural resource managers, etc) • Four Briefing notes on topical issues, delivered to DEWHA and relevant local, state and federal government staff, including ministers, senators and policy advisors • What's new with the e-Atlas - Progress report on data agreements, metadata and data input into the e-Atlas and technical alignment with the DEWHA, GBRMPA and WTMA • Details of eight activities enhancing engagement and adoption of the e-Atlas (activities will vary between quarters but could include end user briefings, responses to requests from e-Atlas users, e-Atlas training sessions) • Updates to the RRRC/MTSRF website, including the latest metadata list for publicly available technical, interpreted and synthesised information, highlighting additions this quarter	29 Jan 2010 (Q14)	$147,500

For 2009/10 Outputs Only Milestones	Date	MTSRF To RRRC
• Website visitation statistics • One awareness-raising event for the MTSRF (for example participation in and distribution of MTSRF materials at relevant conferences) • Three Communiqués targeted to key end user groups (RRRC Communiques are strongly focused on MTSRF information - all scientific content is reviewed by scientists prior to publication – content and target end user group will vary each quarter. See http://www.rrrc.org.au/publications/communique_online.html for previous examples) • Four media releases (supplied to DEWHA for approval prior to release) or fact sheets distributing synthesised MTSRF information to the community and/or general public • Five MTSRF science updates for industry delivered at meetings with industry representatives • List of presentations delivered by RRRC staff and MTSRF researchers, with copies of presentations where possible • Evaluations of delivery success (eg media monitoring, number of newsletters distributed, or other indicator) In addition: • Four draft issues-based synthesis reports aligned with the original Research Investment Strategy* provided to CERF team for comment • Final Proceedings of the 2009 Annual MTSRF Conference (if comments on draft are received from the CERF team by 31 Dec 09) • Draft Pathways to Impact report provided to CERF team for comment • Draft plan for the 2010 Annual MTSRF Conference provided to CERF team so that the CERF team can facilitate attendance by as many DEWHA staff as possible		
Written report provided to DEWHA containing descriptions of this quarter's activities enhancing delivery (Jan-Mar 2010), including copies of documents and reports as follows:: • Maintenance of the MTSRF's engagement framework – details of this quarter's four Operations Committee meetings and three Steering Committee meetings, plus the minutes of the previous quarter's meetings • Synthesised MTSRF science updates for each project within each research area, delivered to relevant Steering Committees • Research Director's report to the RRRC Board • Four Essential Science delivery sessions featuring peer-to-peer communication with key end user groups – audiences will vary between quarters but will include local, state and federal government staff, management agencies, end user organisations such as Ergon or ports authorities, environmental NGOs and general public • Responses to requests from the Environment Portfolio and other federal government bodies for information/materials (usually 8-10 per quarter) • Four personal briefings delivered to federal and state government ministers and their advisors	28 April 10 (Q15)	$147,500

For 2009/10 Outputs Only	Date	MTSRF
Milestones		**To RRRC**
• Twenty personal briefings delivered to other end user groups (these end user groups will vary between quarters but will include Councils, NGOs, natural resource managers, etc) • Four Briefing notes on topical issues, delivered to DEWHA and relevant local, state and federal government staff, including ministers, senators and policy advisors • What's new with the e-Atlas - Progress report on data agreements, metadata and data input into the e-Atlas and technical alignment with the DEWHA, GBRMPA and WTMA • Details of eight activities enhancing engagement and adoption of the e-Atlas (activities will vary between quarters but could include end user briefings, responses to requests from e-Atlas users, e-Atlas training sessions) • Updates to the RRRC/MTSRF website, including the latest metadata list for publicly available technical, interpreted and synthesised information, highlighting additions this quarter • Website visitation statistics • One awareness-raising event for the MTSRF (for example participation in and distribution of MTSRF materials at relevant conferences) • Three Communiqués targeted to key end user groups (RRRC Communiques are strongly focused on MTSRF information - all scientific content is reviewed by scientists prior to publication – content and target end user group will vary each quarter. See http://www.rrrc.org.au/publications/communique_online.html for previous examples) • Four media releases (supplied to DEWHA for approval prior to release) or fact sheets distributing synthesised MTSRF information to the community and/or general public • Five MTSRF science updates for industry delivered at meetings with industry representatives • List of presentations delivered by RRRC staff and MTSRF researchers, with copies of presentations where possible • Evaluations of delivery success (eg media monitoring, number of newsletters distributed, or other indicator) In addition: • Program for the 2010 Annual MTSRF Conference provided to CERF team • Draft Benchmarking Survey 2009 Report provided to CERF team for comment • At least three draft issues-based synthesis reports aligned with the original Research Investment Strategy* provided to CERF team for comment • Draft report describing case studies of MTSRF impact and uptake provided to CERF team for comment • At least two final issues-based synthesis reports aligned with the original Research Investment Strategy* (if comments on drafts are received from CERF team by 31 Mar 10) • Final Pathways to Impact report (if comments on draft are received from the CERF team by 31 Mar 10)		

For 2009/10 Outputs Only	Date	MTSRF
Milestones		**To RRRC**
Written report provided to DEWHA containing descriptions of this quarter's activities enhancing delivery (Apr-Jun 2010), including copies of documents and reports as follows: • Maintenance of the MTSRF's engagement framework – details of this quarter's four Operations Committee meetings and three Steering Committee meetings, plus the minutes of the previous quarter's meetings • Synthesised MTSRF science updates for each project within each research area, delivered to relevant Steering Committees • Research Director's report to the RRRC Board • Four Essential Science delivery sessions featuring peer-to-peer communication with key end user groups – audiences will vary between quarters but will include local, state and federal government staff, management agencies, end user organisations such as Ergon or ports authorities, environmental NGOs and general public • Responses to requests from the Environment Portfolio and other federal government bodies for information/materials (usually 8-10 per quarter) • Four personal briefings delivered to federal and state government ministers and their advisors • Twenty personal briefings delivered to other end user groups (these end user groups will vary between quarters but will include Councils, NGOs, natural resource managers, etc) • Four Briefing notes on topical issues, delivered to DEWHA and relevant local, state and federal government staff, including ministers, senators and policy advisors • What's new with the e-Atlas - Progress report on data agreements, metadata and data input into the e-Atlas and technical alignment with the DEWHA, GBRMPA and WTMA • Details of eight activities enhancing engagement and adoption of the e-Atlas (activities will vary between quarters but could include end user briefings, responses to requests from e-Atlas users, e-Atlas training sessions) • Updates to the RRRC/MTSRF website, including the latest metadata list for publicly available technical, interpreted and synthesised information, highlighting additions this quarter • Website visitation statistics • One awareness-raising event for the MTSRF (for example participation in and distribution of MTSRF materials at relevant conferences) • Three Communiqués targeted to key end user groups (RRRC Communiques are strongly focused on MTSRF information - all scientific content is reviewed by scientists prior to publication – content and target end user group will vary each quarter. See http://www.rrrc.org.au/publications/communique_online.html for previous examples) • Four media releases (supplied to DEWHA for approval prior to release) or fact sheets distributing synthesised MTSRF information to the community and/or general public • Five MTSRF science updates for industry delivered at meetings with industry representatives • List of presentations delivered by RRRC staff and MTSRF researchers, with copies of presentations where possible • Evaluations of delivery success (eg media monitoring, number of newsletters distributed, or other indicator) In addition: • Description of the 2010 Annual MTSRF Conference	28 Jul 10 (Q16)	$147,500

For 2009/10 Outputs Only	Date	MTSRF
Milestones		**To RRRC**
Beyond July 2010, RRRC will continue producing and delivering issues-based synthesis reports aligned with the original MTSRF Research Investment Strategy 2006-2010 (RIS). This very large task cannot be completed prior to this date because most research projects do not submit their final milestone reports until Jun 2010. The following key MTSRF products and outcomes were identified in the RIS: • (RIS reference 1.1) Improved knowledge of the distributions of the biota and associated habitats of the North Queensland's public environmental assets, and their inter-relationships, particularly including inter-reefal and shoal habitats and human impacts on them. • (1.2) Reports on the condition, trends and projected futures of the following nationally threatened species; including identification and evaluation of the key threats to them and evaluation of available management options to improve their status: Marine turtles, dugongs, breeding seabirds and sharks; Cassowaries and arboreal mammals; Rare and threatened species and ecosystems of coastal lowland communities • (1.3) Reports identifying appropriate indicators of overall system health in changing environments, including indicators for the ecological state of the region and the best ways to capture and integrate biophysical data generated by monitoring programs; identification and mapping of spatial distribution and magnitude of pressures impacting on the ecological condition eg invasive species, development pressures, habitat fragmentation, dieback, visitor pressures; appropriate socio-economic indicators to describe the effects of changes in the ecological state of the region and changes in its management; and regional maps outlining areas of high and low sensitivity to future environmental change. • (1.3) Improved monitoring tools including methods and opportunities for using remote sensing technology and automated sampling systems, and for collecting and incorporating industry and community collected data. • (1.3) Methods for identification and evaluation of factors, including local management strategies, that underpin the resilience of North Queensland's ecosystems, particularly key marine ecosystems (reefs, shoals, seagrass communities) • (2.1) a report on the predicted impacts on the North Queensland region and sub-regions from changes in climate, including indication of level of spatial and temporal confidence associated with the predictions, and how we might adapt to or mitigate these impacts locally and regionally; • (2.1) a report on likely marine system responses to shifts in fundamental physics for North Queensland – upwellings, current changes, gyre reversals • (2.1) a report on likely water cycle/water resource scenarios • (2.1) a report on the likely impacts of changing climate on marine and terrestrial biodiversity – key species (corals, arboreal mammals, breeding seabirds, turtles), habitats (coral reefs, seagrass, islands and cays), ecosystems – and how these systems might adapt under predicted climate change, including identification of key refugia and important landscape links, and	Beyond Jul 2010	

For 2009/10 Outputs Only	Date	MTSRF
Milestones		**To RRRC**
guidelines for design of refugia to allow for movement of organisms and persistence of gene pools; • (2.1) a report on how climate change and its primary impacts (eg coral bleaching) might interact with other threats such as clearing, fragmentation, fire, urbanisation, weeds, feral animals, declining water quality, crown-of-thorns starfish, storms and land uses to impact on environmental assets, including identification of those which have the greatest potential for substantial impact • (2.1) a report on resilience of North Queensland regional ecosystems & how to enhance it within scenarios of increased climate variability. Regional maps (projected to year 2050) outlining likely changes to North Queensland environmental assets given a variety of scenarios for future warming, responses of biota and management interventions • (2.1) Seasonal outlooks on coral bleaching and enhanced early warning systems to assist GBRMPA to deliver on its Coral Bleaching Response Plan and improved ability to quantify predicted bleaching and mortality impacts as a result of future bleaching events • (2.1) Report providing improved knowledge of mechanisms behind and processes affecting coral community resilience after repeated mass bleaching events • (2.2) A report on the primary and secondary risks posed by existing introduced pest species to the North Queensland region, identifying the best practices for prevention or control of these species, the implications of using these methods, and the habitat types and regions that are most susceptible, including maps of current, trends and projected distribution of spread and impact of these invasive pests at scales relevant to local and regional management • (3.1) Report on the relationships between catchment processes, pollutant loads delivered to instream environments (including wetlands and estuaries) and the marine park, and the impacts on instream environments and the nearshore marine environment • (3.1) Report on the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) with regard to impacts on instream environments (including wetlands and estuaries) and marine park ecosystems (coral reefs, seagrass beds, mangroves and pelagic /water column ecosystems) • (3.1) A report on optimising water quality and impact monitoring and evaluation programs, including improved indicators for water quality, ecosystem health and key indicators of instream (including wetlands and estuaries) and inner Great Barrier Reef ecological responses to changes in water quality • 3.1) A report identifying key social and economic factors, including land management practices, that influence changes to the generation and delivery of water quality contaminants to instream environments (including wetlands and estuaries) and to the Great Barrier Reef • (3.1) A risk assessment framework for identifying and evaluating appropriate land management strategies to improve water quality and a report identifying parameters for determining land condition impacts on water quality		

For 2009/10 Outputs Only	Date	MTSRF
Milestones		**To RRRC**
• (4.1) A report on the best evaluation frameworks to compare the performance of alternative environmental management strategies including robust environmental, social and economic performance measures and how we can best develop these frameworks • (4.1) A report on the best ways to use available knowledge, particularly traditional knowledge, to support sustainable use and management of our environmental assets • (4.2) A report on how we can better understand trade-offs in types of land use, particularly changes in coastal land use, and possible impacts on biodiversity, water and soil resources • (4.2) A report on the likely medium and long term primary and secondary ecological impacts of the predicted population growth and associated urban and rural development in North Queensland coastal environments; including implications for Terrestrial habitat loss, modification and fragmentation; Identifying the landscapes and ecosystem processes that are most at risk; identifying the biological and ecological value of regrowth, modified, disturbed and/or fragmented vegetation at a landscape scale; and identifying the fragmentation, patch size and connectivity thresholds for maintenance of biodiversity and ecosystem processes; Infrastructure; Water quality and local and regional water resource demands; and Tradeoffs in land use • (4.2) Reports on the best land rehabilitation practices and their costs and benefits in environmental, social and economic terms, including identification and evaluation of options for large-scale rehabilitation following decommissioning of redundant infrastructure (eg powerlines or roads); Identification and evaluation of cost-effective techniques for rehabilitating degraded sites, particularly restoring ecological connectivity in infrastructure corridors, including evaluation of thresholds for patch size and corridor width for wildlife in different landscape types, and for different landscape scales; Evaluation of past and potential management interventions to re-establish natural successional processes in disturbed and weed-infested native vegetation • (4.3) A report on the ecological, economic and social effects of the 2003 Great Barrier Reef Zoning Plan • (4.3) A report on strategies to better mitigate the environmental impacts of Great Barrier Reef fisheries • (4.3) A report on the relative social and economic values of key marine species, particularly large fish around tourist facilities • (4.3) A report identifying high risk locations and conditions for human encounters with irukandji and other marine stingers, based on understanding and analysis of life history characteristics and environmental parameters • (4.3) A report on the sustainability of Indigenous harvest of marine resources focussing on the current and future economic and social drivers for the use of these resources • (4.3) An analysis of environmental management charge data, with other relevant data (National and International Visitor Surveys), to explore tourism trends and drivers • (4.3) Report identifying key influences on resilience of key marine ecosystems (reefs, shoals, seagrass), and potential strategies to		

For 2009/10 Outputs Only	Date	MTSRF
Milestones		**To RRRC**
enhance that resilience • (4.4) An identification of the social and economic value of environmental assets, including those related to nature-based tourism, in the Wet Tropics World Heritage Area and their flow-on benefits to the community		
Total MTSRF Funding		**$737,500**

Project 5.10 Budget

Year 1 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF*	$737,500	-	$737,500
Total	**$737,500**	**-**	**$737,500**

* This includes the $79,000 Communication Products allocation from projects within Themes 1 to 4, held by Reef and Rainforest Research Centre allocated against this activity.

Project 5.10 Budget 2009/10

Item	MTSRF Funds	Funds from Other Sources	Total Cost
Salaries	$267,500	-	$267,500
External contracts	$192,500	-	$192,500
Products	$92,500	-	$92,500,
Travel	$92,500	-	$92,500
Communication / Extension	$92,500	-	$92,500
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$737,500**	**-**	**$737,500**

PROGRAM 10: ENHANCING DELIVERY

Project 5.10.1: Communication tools for MTSRF Projects

Project Leader and Host Organisation

Reef and Rainforest Research Centre Ltd

Project Team Commitment 2009/10

Title	Organisation	Role	FTE
Dr Suzanne Long	RRRC	Project leader	0.1
Shannon Hogan	RRRC	Project officer	0.2

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
DEWHA	Gareth Evans
Researchers	MTSRF Research Providers
Stakeholders	End users of MTSRF Research

Project Duration

Start Date: 1 July 2006 End Date: 30 June 2010

Project / Task Objectives

In previous years this project has focused on creating a high-quality visual record of the MTSRF program for use in multimedia and public presentations, with the aim of disseminating the results to the public and end users. Most of the necessary films have now been produced and will shortly be available for public dissemination. Consequently, while filming of future MTSRF findings and activities will continue through ARP4 and beyond, the scope of this project will expand to include a range of other communication tools designed to enhance delivery of results deriving from all four research themes of MTSRF. The immediate priority for this project during ARP4 will be the filming of Essential Science sessions for web-based public dissemination, along with the continued compilation of a high quality still image library containing images that can be used freely for all RRRC/MTSRF applications.

This project has been formed through contributions amounting to $79,000 from projects within Themes 1-4. Its purpose is to deliver strategic communication tools that will assist in the delivery of MTSRF science to targeted end users, as well as the community that has funded MTSRF.

Project Targeted Activities

Targeted Activity	Date
Generation of strategic communication tools in line with the RRRC Strategic Plan to Enhance Delivery, facilitating end user uptake of results from Themes 1-4	Ongoing
Continued visual documentation through generation, acquisition, and contribution of high quality digital imagery of MTSRF projects, their operations, the natural environmental assets of North Queensland and their uses, as well as delivery of this information to end users. The material is to cover the full range of MTSRF activities and is to be available for use for all RRRC and MTSRF applications, including in the media as appropriate.	Ongoing to 2010
Provide periodic reports of all communication tools (including visual documentation) developed/acquired during that quarter, and information about their use to date	Biannually

Project 5.10.1 Milestones 2009/10

For 2009/10 Outputs Only Milestones	Date	MTSRF
Written report provided to DEWHA, containing, in addition to standard milestone report information: • Description of all project activities during this period • Examples of use of this project's communication tools during this period for RRRC/MTSRF applications	28 Oct 09 (Q13)	$31,877
Written report provided to DEWHA, containing, in addition to standard milestone report information: • Description of all project activities during this period • Examples of use of this project's communication tools during this period for RRRC/MTSRF applications	28 Apr 10 (Q15)	$31,877
Total MTSRF Funding		**$63,754**

Project 5.10.1 Budget

Year 1 – 2009/10 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
MTSRF*	$63,754	-	$63,754
Total	**$63,754**	**-**	**$63,754**

* The total Communication Products allocation from projects within Themes 1 to 4, held by Reef and Rainforest Research Centre, is allocated against this activity.

Project 5.10.1 Budget 2009/10

Item	MTSRF Funds	Funds from Other Sources	Total Cost
Salaries	$25,000	-	$25,000
Generation/acquisition of material	$10,127	-	$10,127
Travel	$18,500	-	$18,500
Communication / Extension	$10,127	-	$10,127
Capital	-	-	-
Institutional overheads	-	-	-
Total	**$63,754**	**-**	**$63,754**

PROGRAM 10: ENHANCING DELIVERY

Project 5.10.2: Communication, engagement and enhanced delivery for tourism operators in the Wet Tropics Rainforests

Project Leader and Host Organisation

Tourism Tropical North Queensland (TTNQ)
in association with the Reef and Rainforest Research Centre Ltd

Project Team Commitment 2009/10

Title	Organisation	Role	FTE
Annie Riddet	TTNQ	Project leader	0.05
Rob Giason	TTNQ	Strategic direction	0.025
Dr Suzanne Long	RRRC	Strategic direction	0.01

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
Wet Tropics tourism operators	Various

Project Duration

Start Date: 1 July 2009 End Date: 30 June 2010

Project / Task Objectives

In recognition of the fact that the north Queensland tourism industry is a major end user of MTSRF research conducted in the Wet Tropics rainforest ecosystems, there is a need for enhanced delivery of MTSRF results into this sector. This should occur in line with MTSRF's overarching plan to enhance delivery. In addition, dedicated facilitation of engagement between researchers and this industry is required, also within the context of the engagement system and framework of the MTSRF.

This schedule describes the major activities to be undertaken by a Tropical Tourism North Queensland (TTNQ) representative working across the Cairns and Townsville nodes of the Industry. The representative is expected to use their comprehensive knowledge of the north Queensland ecotourism industry to enhance delivery of MTSRF information such that it benefits operators by improving the environmental sustainability of their management, policy or practice.

Project / Task Objectives for 2009/10

(a) To develop and use mechanisms to enhance the delivery of research findings and uptake by the Tropical Ecotourism sector in north Queensland.
(b) To report on the success of these mechanisms in enhancing delivery.

Project Activities 2009/10

Objective	Targeted Activity	Date
all	Develop and assess the usefulness of various methods of identifying MTSRF messages and delivering these messages to ecotourism operators in the region	ongoing
(a)	Deliver relevant research findings to the region's ecotourism industry	ongoing
(b)	Monitor and evaluate delivery success of communication products, using a combination of indicators/proxies	ongoing
all	Liaise with and report to Reef and Rainforest Research Centre on activities and outcomes, particularly with regard to the identification of relevant MTSRF research.	ongoing

Project 5.10.2 Milestones 2009/10

For 2009/10 outputs only **Milestones – All TTNQ Responsibilities**	**Date**	**MTSRF**
Written report to RRRC describing communication activities involving MTSRF research in this reporting period. The report will include an evaluation of delivery success (for example website statistics showing number of views or downloads of MTSRF-derived information), as well as notes describing any evidence of uptake of MTSRF research by the industry.	30 Sep 09	$10,000
Written report to RRRC describing communication activities involving MTSRF research in this reporting period, including MTSRF/RRRC participation in TTNQ's Research Forum in Oct/Nov. The report will include an evaluation of delivery success (for example website statistics showing number of views or downloads of MTSRF-derived information), as well as notes describing any evidence of uptake of MTSRF research by the industry.	15 Jan 10	$10,000
Written report to RRRC describing communication activities involving MTSRF research in this reporting period, including MTSRF/RRRC participation in TTNQ's Research Forum in May. The report will include an evaluation of delivery success (for example website statistics showing number of views or downloads of MTSRF-derived information), as well as notes describing any evidence of uptake of MTSRF research by the industry.	31 May 10	$10,000
Total MTSRF Funding		**$30,000**

Project 5.10.2 Budget 2009/10

Tourism Tropical North Queensland Project 5.10.2 Budget 2009/10

Item	MTSRF Funds	Funds from TTNQ In-kind	Total Cost
Salaries	$5,000	-	$5,000
Operating	$2,000	-	$2,000
Travel	$1,000	-	$1,000
Contractors – Industry Consultation	$10,000	-	$10,000
Contractors – Communication and PR	$12,000	-	$12,000
Capital	-	-	-
Service provider overheads	-	-	-
Total	**$30,000**	**TBA**	**$30,000**

PROGRAM 10: ENHANCING DELIVERY

Project 5.10.3: Communication, community engagement and enhanced delivery for Indigenous knowledge of the MTSRF Region

Project Leader and Host Organisation

Jean Fenton and Melissa George, The Sezoni Trust trading as George Fenton

Project Team 2009/10

Title	Organisation	Role	FTE
Jean Fenton	George Fenton Consulting	Project Leader, co-ordination	1.0
Melissa George	George Fenton Consulting	Project Leader, co-ordination	1.0

Summary Table of Research Users 2009/10

Organisation	Organisational Contact
Girringun Aboriginal Corporation	Mr Phil Riske
Wet Tropics Management Authority	Mr Nigel Hedgecock
Reef and Rainforest Research Centre	Ms Mellissa Jess

Project Duration

Start Date: August 2009 End Date: June 2010

Project Description / Task Objectives

There is an identified need within the Marine and Tropical Sciences Research Facility (MTSRF) to broaden the engagement with Indigenous peoples within the GBR Reef Catchment and the Wet Tropics World Heritage Area In order for the MTSRF/RRRC to ensure the conservation and sustainable use and management of environmental assets within the far north a dialogue must occur with Indigenous peoples which provides for meaningful engagement and the delivery of outcomes beyond the environment, to support broader outcomes associated with Indigenous peoples needs at a community level. There are currently a number of processes being delivered to Indigenous communities but they seem to be uncoordinated and ad hoc.

This project aims to enhance emerging mechanisms to increase Indigenous people's engagement and meaningful involvement of research organisations by creating an Indigenous specific second generation research directions report that reflects what is needed at the community level. This report will identify new and innovative ways forward with a mutually beneficial approach.

Project / Task Methodology

The majority of this project will be undertaken by a small research team who will meet with Indigenous organisations and Leaders to scope Indigenous NRM needs and services, investigate appropriate governance models for cross cultural environmental research and management and undertake case studies of existing Indigenous NRM arrangements in the MTSRF region. Upon completion of this project there will need to be further work undertaken to finalise the Indigenous specific research directions report and to ensure that there is an opportunity for Indigenous groups with the MTSRF geographical area to ground truth and agree on its final content.

Project Outputs/Outcomes

To ensure that the Indigenous Research Directions Report is comprehensive the following outputs will be achieved:

- Scope out how Indigenous NRM can be used to achieve community aspirations and environmental management outcomes via the provision of environmental services;
- Map out existing Indigenous Infrastructure/Organisations;
- Identify current Land and Sea management arrangements and programs;
- Investigate appropriate research governance models e.g Cooperative Research Centre for Aboriginal Health; and
- Undertake analysis of 4 Case Studies to demonstrate the above:
  1. Girringun Aboriginal Corporation
  2. Chuula/Lochardt
  3. Curtis Coast
  4. Torres Strait Region
- Identify content of Research Directions Report based on outcomes of above.

Project Milestones 2009/10

Objective	Targeted Activity	Completion Date
1	Map out existing Indigenous Infrastructure/Organisations	31 August 2009
2	Identify current Land and Sea management arrangements and programs	31 August 2009
3	Undertake four Case Studies to investigated the strengths and gaps in current processes and structures	30 September 2009
4	Scope out Indigenous specific Content of Indigenous Research Directions Report	31 October 2009
5	Ground truth process identified in Indigenous Research Directions Report.	15 December 2009

Project 5.10.3 Milestone Payments 2009/10

For 2009/10 outputs only	Date	MTSRF
Milestones		**George Fenton**
Signing of Contract	2009/10	$20,000
Progress report on • Map of existing Indigenous Infrastructure/Organisations • Identification of current Land and Sea management arrangements and programs	31 August 2009	$5,000
Progress report on four Case Studies to demonstrate above and gaps and content on Indigenous Research Directions Report	31 October 2009	$5,000
Final Report as a Synthesis of Indigenous Research Directions in the MTSRF Region.	15 December 2009	-
Total MTSRF Funding		**$30,000**

George Fenton Project 5.10.3 Budget

2009/10 Project Funding and Partnerships

Contributing Organisation	MTSRF	Total Cost
Salaries	$22,000	$22,000
Operating	$6,000	$6,000
Travel/Accommodation	$2,000	$2,000
Total (GST exclusive)	**$30,000**	**$30,000**